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# Mobile Radio Technology

The journal of mobile communications technology



Practical alpha paging, p. 10

Data signaling requirements

- Cellular antenna theory

- Low-gain cellular antennas





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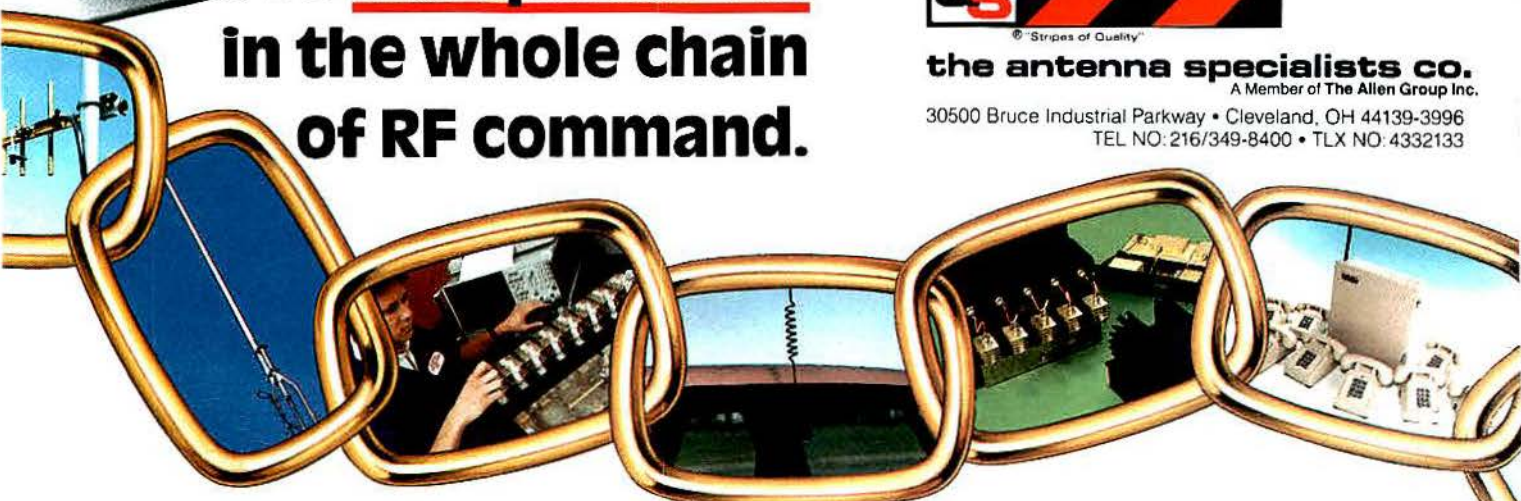


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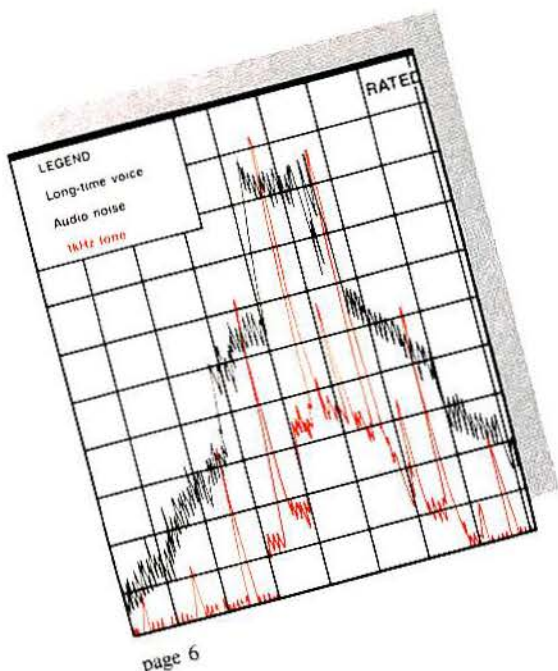
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## Station identification helps to resolve interference



The most important element in resolving interference problems is station identification—call signs, in other words.

Why doesn't everyone use call signs? A combination of reasons, probably:

(1) The radio users may never have been told what the call sign is.

(2) If they have been told the call sign, they may not have been reminded to use it. The call sign may not be posted on the radio or the dashboard for easy reference.

(3) The person in charge of the system may not think it is important to use the call sign or may not have the authority to tell operators to use it.

It is easier and faster to say "Unit one to unit two" than to say "KXX III unit one to unit two." Shortcuts are natural. But FCC rules and good spectrum management practice dictate that the call sign must be given at the beginning and end of a communication and at intervals if the communication is lengthy.

### Joe Friday

Jack Webb, who produced *Dragnet* and *Adam 12* for television, modeled his productions as closely to recommended police procedures as possible. We remember seeing a production in which he, in character as Sgt. Joe Friday, delivered a lengthy description of a criminal suspect into a mobile two-way radio microphone. He concluded his broadcast by giving a radio call sign!

For whatever the reason, it is difficult to persuade radio users that using call signs is important. Here is one example of how important it is:

Signals from two or more radio transmitters can interact to produce a third, unwanted signal that causes interference. Neither transmitter alone is *at fault*, but when they operate simultaneously, interference results. This type of interference is "intermodulation interference," or "intermod." It may involve an interaction among more than two transmitters.

With sufficient time and equipment, it may be possible to calculate and confirm the signal frequencies that result in intermod. With more time and equipment, it may be possible to use radio direction-finding techniques to trace the signals to their sources, where filters or other devices may be applied to eliminate the problem.

### Somebody pays

The investigation may be expensive. *Somebody* pays: the radio users, the service shop and, if the FCC is involved, all of us as taxpayers, for example.

But if the signals include call signs, a period of monitoring may be all that is required to identify the users, their frequencies and equipment locations. The cost saving can be enormous, and the problem may be resolved much more quickly.

Another technical problem that can cause interference is a "spurious emission," or "spur." A spur is a signal on an unintended frequency that emanates from a transmitter simultaneously with a desired broadcast. It usually results from maladjustment of the equipment or a defective component.

Tracing the source of a spur that causes interference may be as difficult as tracing the source of intermod. Once again, if the operator of the transmitter uses a call sign, the source may be traced quickly through records. Normally a simple repair is all that is required to eliminate the spur.

### Automatic identification

Many repeater system operators use automatic station identification equipment that transmits the system

call sign in Morse code automatically at intervals. That is quite helpful, and the practice should be encouraged.

System operators who do not use automatic station identification should redouble their efforts to use call signs.

Community repeater operators may be reluctant to ask their customers to use call signs, thinking the request would be too burdensome. But the payoff comes when interference strikes and an otherwise lengthy investigation might have to begin, not to mention the inconvenience the interference may cause those same customers in the meantime.

Controlling interference seems to be a high priority with equipment dealers, repeater operators and major end-users. Yet some of these same people are reluctant to use their call signs.

### Number one on the list

We've asked a number of FCC field engineers what steps radio users can take to help to eliminate interference. Number one on every engineer's list is the use of call signs.

(Number two, if you want to know, is the posting of copies of license documents on all base station transmitters. Number three is the posting of the name and 24-hour telephone number of the site manager at the access point to transmitter sites.)

Want to control interference? The first step is easy: Use call signs.

—Don Bishop



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Volume 1, No. 5

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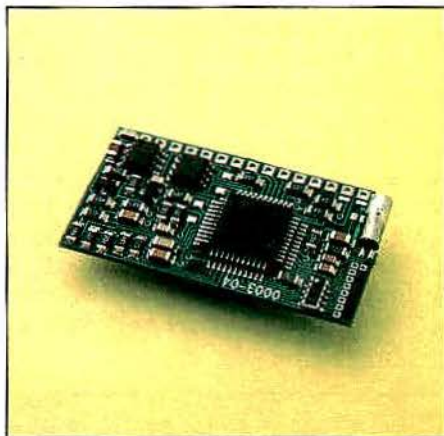
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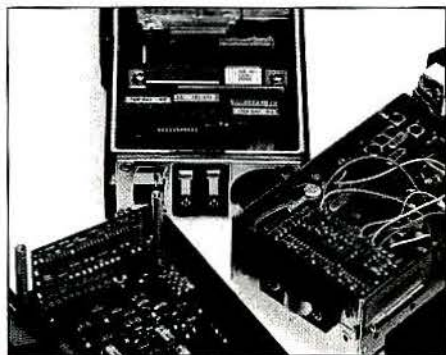
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### ACSSB:

The August "News" department included an item that summarizes an IEEE paper presented by L. Boucher and H.M. Hafez concerning interference in ACSSB systems. This paper concluded that 10kHz, rather than 5kHz, channel spacing is more appropriate for ACSSB systems and that ACSSB systems cannot be operated between 30kHz-spaced FM systems without degrading the FM systems' performance.

As an engineer who assisted in the development of ACSSB products at Sideband Technology (STI) and later at Aerotron, I disagree with the conclusions presented in the summary. They give a distorted and disparaging view of this important technology. There are many thousands of ACSSB radios in daily operation in this country. Most, if not all, operate between FM assignments. It is my understanding that there have been

few reported incidents of interference caused by these ACSSB systems, in large part because frequency coordination is required for all new systems in the 150MHz-to-170MHz band.

The authors' conclusion that 10kHz channel spacing is more appropriate for ACSSB systems is based upon achieving a disruptive adjacent channel protection ratio of 70dB, equivalent to that measure for FM into FM at a 30kHz channel spacing. The disruptive adjacent channel protection ratio for ACSSB into ACSSB was measured at only 40dB at a 5kHz channel spacing and reached 70dB at a 10kHz channel spacing. The conclusion that 10kHz channel spacing is required for ACSSB systems is not supportable for several reasons.

First, the ACSSB equipment used in the test was supplied to the Canadian Department of Communications by STI in early 1983. It is not representative of the adjacent channel performance of

current ACSSB equipment available from several manufacturers. The equipment tested was the first-generation design. It did not incorporate the more linear RF power amplifier introduced in 1984 to improve the adjacent channel protection.

The picture shown in Figure 1 on page 8 of a spectrum analyzer display from a 1984 measurement taken in "MAX HOLD" similar to the measurement taken by the IEEE paper's authors shows the emitted spectrum of an STI radio with the new power amplifier. The emissions in the center of the adjacent channel are approximately 15dB lower with the "new" 1984 power amplifier than the emissions measured with the authors' equipment, shown in Figure 2 of the IEEE paper and as Figure 2 on page 8 in this issue.

If the authors had used ACSSB equipment made after 1983, they probably would have measured an adjacent chan-

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The journal of mobile communications technology

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## Letters to the editor

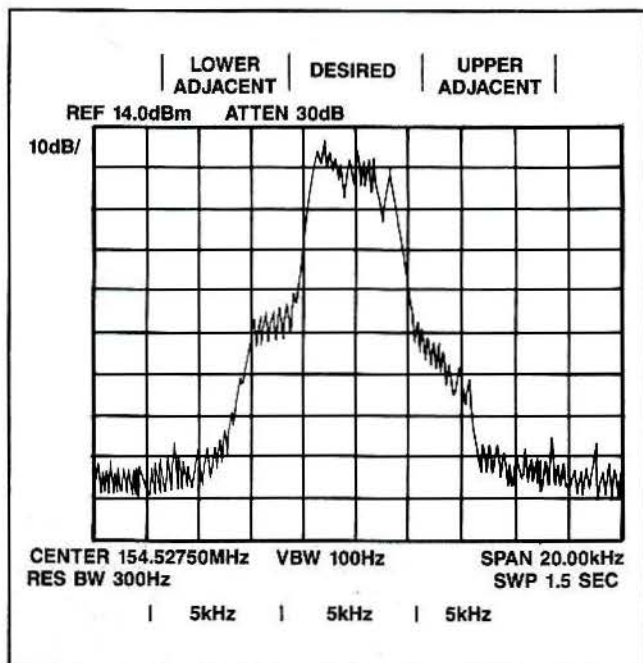


Figure 1. A spectrum analyzer display from a 1984 measurement taken in 'MAX HOLD' is similar to the measurement taken by the IEEE paper's authors. This display, shown as an artist's rendering, shows the emitted spectrum of an STI radio with the 'new' (1984) power amplifier. Emissions in the center of the adjacent channel are approximately 15dB lower with the 'new' power amplifier than the emissions measured with the authors' equipment, shown in Figure 2.

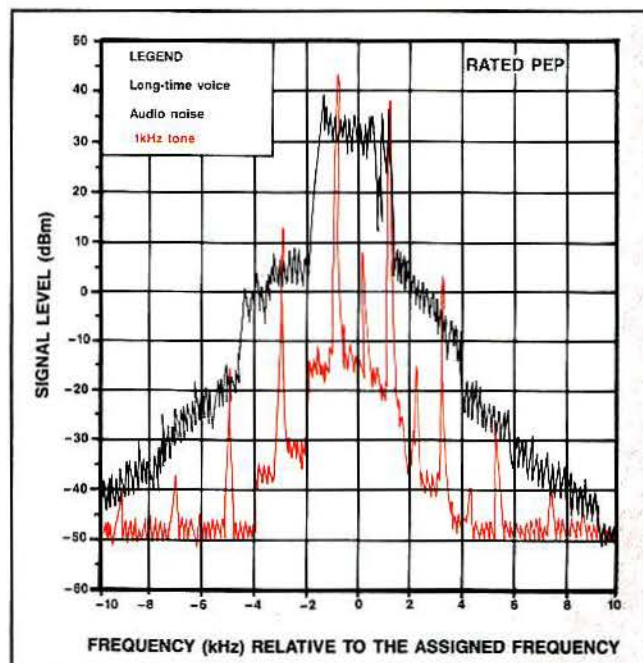


Figure 2. A spectrum analyzer display from the IEEE paper. If the authors had used ACSSB equipment made after 1983, they probably would have measured an adjacent channel protection ratio for 5kHz-spaced ACSSB equipment at 55dB, which is close to the 56dB-to-58dB disruptive protection ratios obtained with the new equipment during numerous tests at STI.

nel protection ratio for 5kHz-spaced ACSSB equipment of 55dB, which is close to the 56dB-to-58dB disruptive protection ratios obtained with the newer equipment during numerous tests at STI.

(Editor's note: The writer sent a photocopy of the Figure 1 spectrum analyzer photograph. Photocopies of photographs do not reproduce well with the process used to print the magazine, so an artist's rendering of the analyzer display appears in Figure 1 above.)

Second, a review of the FCC Part 90 Rules shows that the frequency spacing in the 150MHz-to-170MHz band, where ACSSB equipment use is authorized, is 15kHz, not 30kHz, because of the availability and widespread use of tertiary channel assignments. Therefore, it would be more appropriate to compare the adjacent channel protection of ACSSB equipment at 5kHz spacings to that of FM equipment at 15kHz, rather than 30kHz, spacings. Figure 7 in the IEEE paper shows the disruptive adjacent channel protection for FM into FM at a 15kHz spacing is only 25dB.

Therefore, ACSSB equipment, at its

FCC-authorized 5kHz spacing, provides adjacent channel protection that is 30dB better than that achieved by FM systems at the 15kHz spacings used in this band. In practical terms, this means that ACSSB systems can be implemented with substantially smaller adjacent channel geographic separation distances than would be possible with 15kHz-spaced FM equipment.

The conclusion that ACSSB systems cannot be operated in between 30kHz-spaced FM systems without degrading the FM systems' performance is also flawed, for the same reason. Although the authors' data show that an ACSSB transmitter spaced 15kHz from an FM system produces 25dB more interference to the FM receiver than an FM transmitter does at 30kHz spacing, the data show that an ACSSB transmitter spaced 15kHz from an FM system produces 27dB less interference to the FM receiver than does an FM transmitter at the same 15kHz spacing.

The current state of commercially available ACSSB equipment, although not yet up to the high standards of interference protection set by FM equip-

ment operating at 25kHz or 30kHz channel spacings, is providing substantially better interference protection than 15kHz-spaced FM equipment.

The adjacent channel protection for ACSSB equipment is expected to improve significantly with the introduction of advanced narrowband equipment for the forthcoming 220MHz band. Many of the commenters in this proceeding urged the adoption of a transmitter emission mask with far more stringent requirements than for narrowband equipment in the 150MHz-to-170MHz band. This level of performance soon will be achievable commercially because of advances in transmitter linearization through the use of digital signal processing techniques. Adoption of tough standards will ensure that tomorrow's narrowband equipment will provide a level of interference protection similar to that of 25kHz-spaced FM equipment.

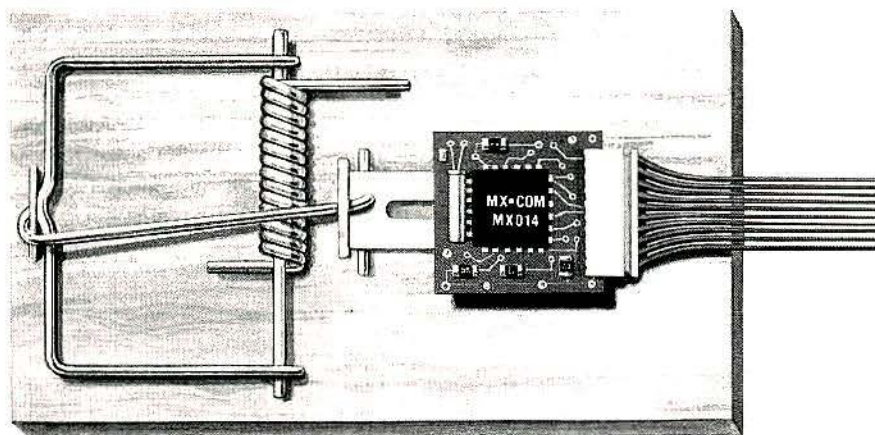
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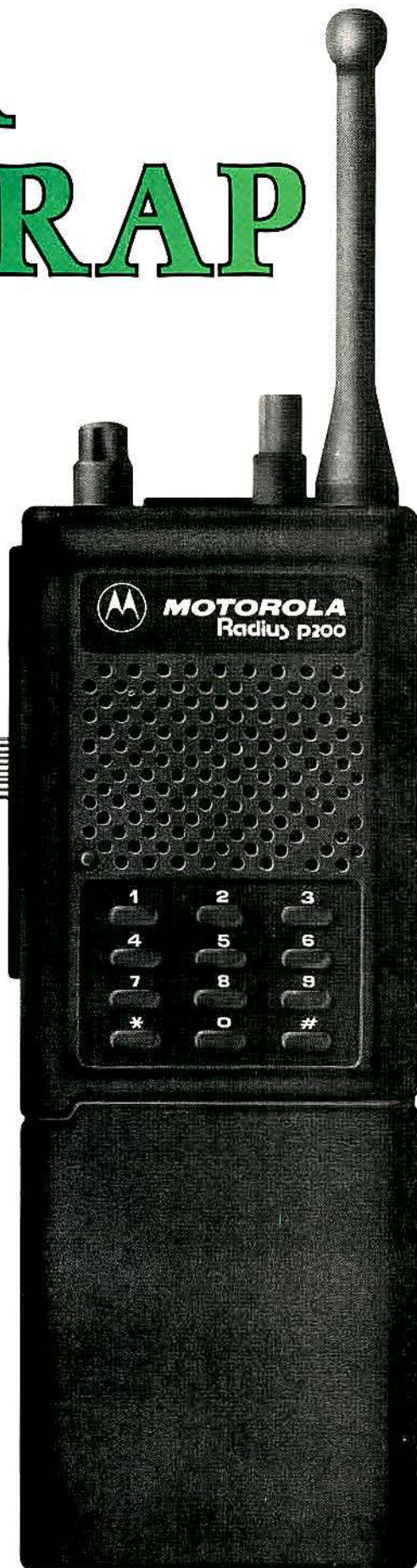
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# Voice mail, computer offer practical alpha paging

*Alphanumeric paging has been slow to win popularity in the United States, chiefly because it has been inconvenient for the caller to send a message. Voice mail and computer technologies deliver a convenient method.*

By Valerie J. McCool

Alphanumeric paging is sensible: It sends the actual text message of a message to the pager.

It is more convenient than a tone-only pager. When someone wearing a tone-only pager hears it "beep," the user must telephone the answering service to pick up the message.

Tone-and-voice pagers convey the message, but not privately and not well or at all if ambient noise is too high.

Numeric pagers give the user a number to call, but if the number is un-

familiar, the user does not know who left the number—or what the message is.

If alphanumeric pagers offer such an advantage over the other types, why does less than 2% of the U.S. paging market use them? The reason is the inability of the *average* caller to send a written message by voice telephone.

Sending an alpha message has required a special terminal or a personal computer with software and a modem to allow the caller to type a message and send it. That means the caller has to be at the input terminal whenever a message needs to be sent—not really convenient!

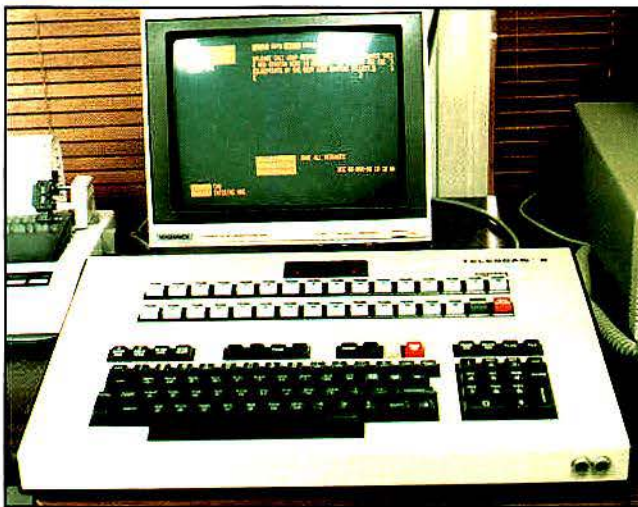
Another option has allowed the caller to use the keypad on a Touch-Tone telephone to spell the message. Imagine

spelling out an 80-character message on a keypad.

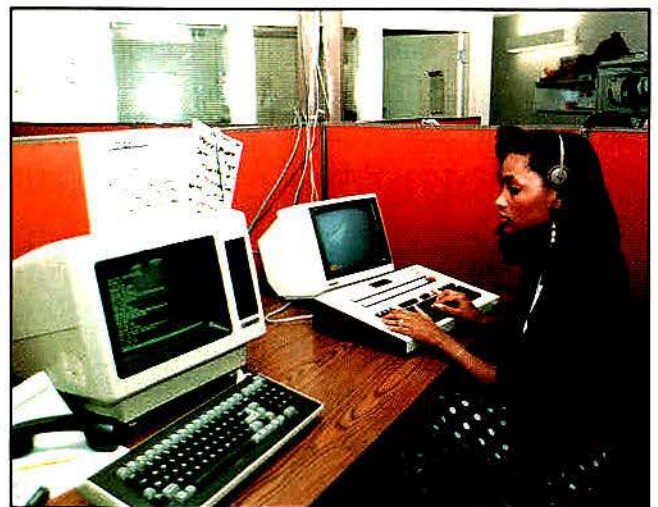
Some alpha pager users take steps on their own to make sending messages easy for their callers. They hire an answering service to take messages from their callers and send them via a terminal or personal computer to their pagers. Although this is a step forward in convenience, most callers do not like being put on hold—a common occurrence when communicating with an answering service operator—or having to repeat their message to verify a correct transcription.

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The operator console displays message forms and controls the replay of callers' recorded voices. Mnemonic keys on the keyboard speed message entry.



Operator Marlene Allen poses at one of several alpha paging entry position at Dial Page, Orlando, FL. The entry position to the left is for the company's telephone answering service.



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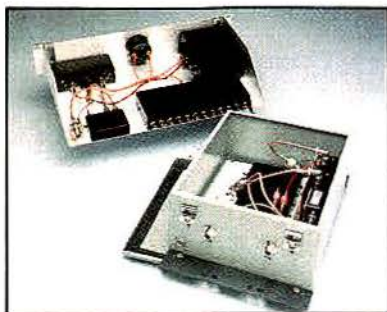


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venience to the caller. The user's pager telephone number is answered by a universal or personalized greeting from the voice mailbox. The caller is instructed to leave a message to be sent via alphanumeric paging. All the caller must do is to speak the message and hang up.

The recorded message is routed to an input operator. When the call is presented, the account's name and message template appear on the operator's video display. The message template is designed for the maximum number of characters allowed for the customer's pager.

The operator activates the recorded message and transcribes it onto the template with the help of mnemonic keys. The mnemonic keys allow words and short phrases to be printed with the press of a key. For example, to type "please call," the operator presses SHIFT P. The paging console has 26 such mnemonic keys.

While transcribing the message, the operator has the option of repeating the entire message or listening to it in five-second increments to ensure an accurate transcription. When finished with the voice message, the operator presses a key to save or erase the message. The carrier can give its customers the option of retaining the voice message in a mailbox for verification later.

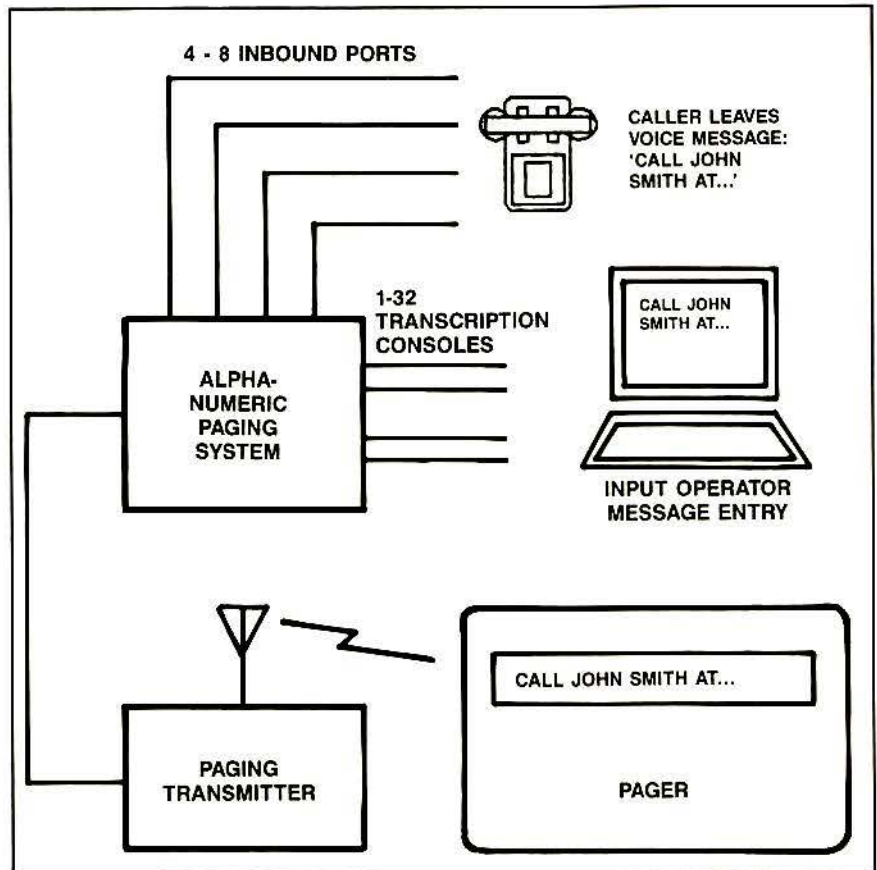
When the operator files the text message, it automatically is sent to the paging terminal along with pager identification information. As many as five paging terminals can be served by one alphanumeric paging system.

### Technical specifications

The alphanumeric paging system supports four to 48 incoming lines, either direct inward dialing (DID) or loop start. The system may be expanded in increments of four ports. DID ports accept either dial pulse or dual-tone multiple-frequency (DTMF) identification. (See Figure 1 above right.)

The voice messaging subsystem uses an Intel 80386 microprocessor running at 20MHz. Depending on voice storage requirements, fixed disk drives of 100 megabytes to 200 megabytes are available. Full transparent redundancy is available for voice storage.

The line interface card digitizes all recordings using adaptive differential pulse code modulation (ADPCM), first



**Figure 1.** The alphanumeric paging system serves as an interface between a caller and a pager user. The caller speaks a message into a voice mailbox. The operator quickly converts the spoken message into a text message that is sent to the pager.



Several computer consoles and printers assist the alpha paging system supervision and management. These units are in a room adjacent to Dial Page's operator positions. Statistics help to track and to identify technical and operational problems.

encoding and then reversing the process for message playback and voice prompts. (ADPCM is a method of encoding digitized voice signals.) About 3 kilobytes of memory is needed for each second of digitized voice.

The control console unit is the interface between the voice message sub-

system and the disk-based text messaging subsystem. The control console unit provides for simultaneous transcription at as many as 32 operator stations.

The text messaging subsystem has as many as 20 megabytes of fixed disk storage and optional transparent redundancy. The voice message is identified in-



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Paging - Analog/Digital

SMR - Simplex/Duplex

### **TELEPHONE COMPANY INTERFACES**

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Battery/Ground, DOD Loop Pulsing, DTMF

(Bell Systems Standards Publication #43303 -

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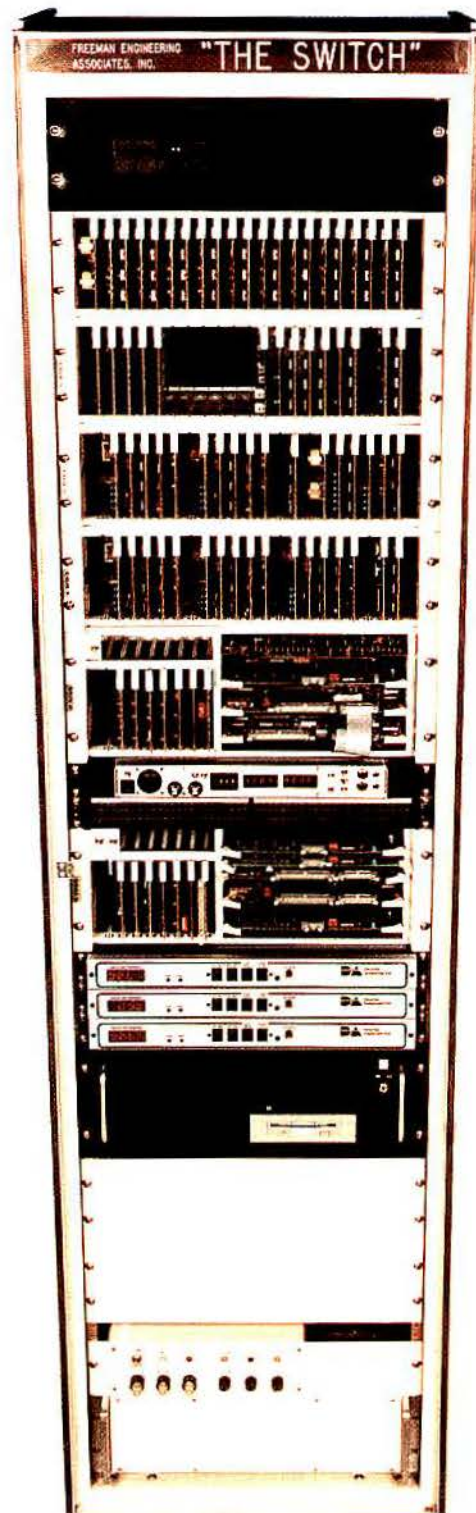
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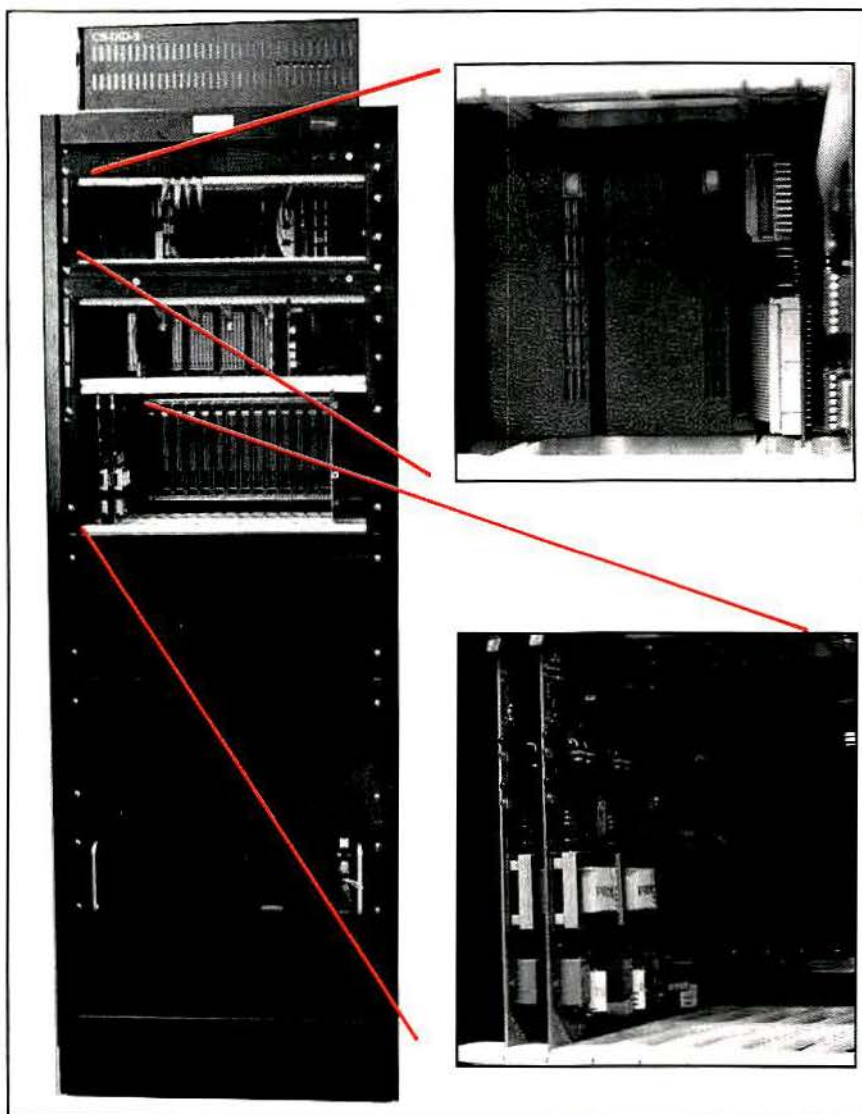
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The alpha paging system equipment, shown with its semi-transparent protective covers removed, includes in its top compartment plug-in voice storage hard disk drives to allow swift replacement. Telephone line cards occupy the lower, exposed compartment.

band with Touch-Tone signaling or dial pulses before being presented to the operator.

Account information and instructions are sent to the operator's video display over a 2.5Mbps serial communication medium (Arcnet).

Message playback is controlled from the operator's keyboard. Transcriptions are fed into a first-in, first-out alphanumeric messenger transmission queue. The text messaging subsystem then formats the message, adds the correct identifier and sends it to the paging terminals either via modem or via direct RS-232 connections at 300bps to 9,600bps.

In an emergency, inbound calls can be routed directly to the control console unit for live transcription of alphanumeric messages.

#### System safeguards

Safeguards built into the system help to ensure the message is transmitted. If a connection is not made with the paging terminal, the system retries as many as nine times. If the transmission still fails, the operator is alerted and can try to transmit the message. If the connection still fails to be made, the operator is informed and further action can be taken.

If the operator did not answer the call

from the system after the caller left the message, the system tries to notify the operator as many as three times. The number of attempts and their lengths are adjustable. If the operator does not respond, the system can be programmed to dial a designated telephone or pager to notify a manager of a potential problem.

Finally, if a message delivered to the mailbox is unclear or in a language the operator does not understand, the operator presses a key that sends the phrase "unintelligible message" to the pager. The operator presses the "SAVE MESSAGE" key to hold the message in the voice mailbox. The customer then may call the mailbox to hear the message when it is convenient.

#### Service variety

The alphanumeric paging system allows the carrier to offer a variety of services to paging customers. Besides saving the voice message, the system can save the text message and transmit it to a remote printer or facsimile machine. Voice prompts for the operator and the paging customer can be multilingual. Rotary dial check-in lines can be used to access stored messages from a non-Touch-Tone phone.

A variety of reports are available from the system, including call traffic statistics, account totals for each pager, port activity and an operator performance report.

The amount of training required to use the system is minimal. The caller simply dials a number and leaves a message. Operator training involves learning the keys on the input console. The keys are well defined and easy to follow. A typical message requires few keystrokes, especially with the use of mnemonic keys. For the supervisor, adding accounts is quick and easy. Each subscriber has an individual account record, into which all pertinent information is entered. The port configuration screen allows as many as five paging terminals to be defined for use with the system.

With the easy operation and the flexibility the alphanumeric paging system offers the caller, carrier and paging customer, alphanumeric pagers should become more appealing and a practical alternative to other types of paging.





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Expansion beyond a single frame is achieved by adding additional frames, each with a Master Processor. This parallel operation is

what we call a Tandem System. The frames are connected via high-speed RS-232 data links and all share a common database and output channels. This architecture allows the system to grow, almost without limit, by adding processing and bus capacity as required. Voice message passing is achieved by voice links in mid-sized systems or by a digital EtherNet LAN in large scale systems.

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## The Model 15 Family

The Model 15 family is based on a chassis that has 15 card slots and an integral power supply. The basic system consists of the chassis, power supply, and the Main Processor. The base system capacity of 15 slots can be expanded in 15 slot increments using X15 expansion chassis, up to a frame capacity of 60 slots (Model 60).

## The Model 20 Family

Just as the Model 15 family is based on a 15 slot chassis, the Model 20 family is based on a 20 slot chassis combined with a separate, rack-mounted power supply. With the additional card capacity and uninterruptable power supply, the Model 20 family is suited to larger system configurations. It expands in 20 slot increments for a frame capacity of up to 80 slots (Model 80).

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# 'Continuous' vs. 'transient' data: Why signaling requirements differ

*Continuous data transfer may require digital signaling, but brief data messages used to support voice communication may be served better by tone signaling that has higher sensitivity and reliability.*

By Frits P. Van Enk  
and Larry Bess

Most modern mobile radio systems use signaling, usually to achieve channel efficiency and often to provide additional services such as access to a central database.

Adding auxiliary services to a mobile radio network does not always boost channel efficiency. For example, automatic access to the public switched telephone network (PSTN) can be a great feature when a limited number of users share a channel.

Spectrum management authorities specify figures as high as 100 mobiles or higher as loading targets. With such high loading, mobile telephone service for even a small group of users may degrade service quality for all users on the channel. The time required to set up the call and for even a short telephone conversation may be prohibitive.

Generally, mobile radio signaling can be categorized as follows:

- **Interference control**—Signaling can be used to block interference. An example is continuous-tone controlled squelch system (CTCSS) signaling used with voice communication to prevent unwanted signals from opening the squelch.

- **Transient information**—Signaling offers a means of transferring short,

Van Enk is engineering manager for GPT Sepac, Springvale, Victoria, Australia. When this article was written, Van Enk was product manager for Sigtone, Los Angeles. Bess is Sigtone's vice president of marketing.

## Definitions

**Channel efficiency** refers to the objective of placing as many mobile and portable units on a channel as possible, consistent with providing the desired service quality.

**Loading** is the number of mobile and portable units on a channel.

**Service quality** is the probability that a given user will have access to a channel when he wants it. The higher the loading, the higher the channel efficiency, but the lower the potential service quality.

transient-type information over the channel. An example is the automatic transmission of identification codes at the start of each transmission.

- **Data communications**—Signaling may be used to provide a full data transfer capability of a semi-continuous nature. Examples include the transfer of computer data over a channel and complex, highly sophisticated networks such as cellular telephone systems.

## Subaudible signaling

In a full data system, received data themselves normally provide an unambiguous indication of the signal's validity, origin and destination. In conventional voice systems, the situation differs.

In conventional analog speech systems, "a carrier is a carrier is a carrier." Unless the carrier bears specifically added identifying information, the receiving device cannot determine the validity of the received signal.

Ideally, the validating information should be present *continuously* because

mobile radio links can be interrupted randomly by interference, fading, temporary loss of signal because of terrain shielding and other intermittent effects.

Continuous signaling almost inevitably is placed outside the common radio communications voice band of 300Hz to 3,000Hz, either below or above those limits. Subaudible signaling—signaling using frequencies below 300Hz—is the preferred method for continuous signaling. Subaudible signaling usually is implemented under the EIA-220A standard for CTCSS. CTCSS has established itself as an effective, powerful method of RF channel protection.

Subaudible signaling is not perfectly suitable for data transfer. But when it is used to set up and maintain a link, CTCSS signaling often is a perfect complement for non-continuous, in-band data transfer systems.

## In-band signaling

When "data," whether short or extended, are transmitted over a radio channel, in-band signaling generally is





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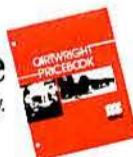
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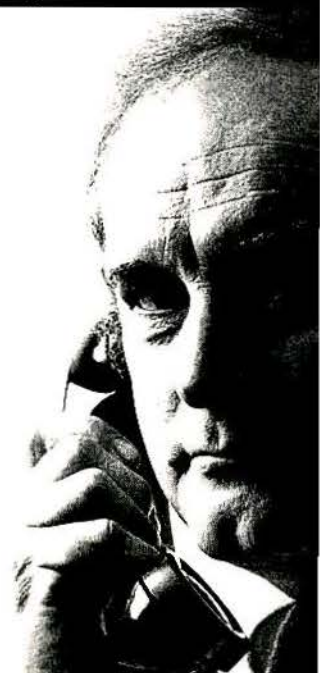
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### Several signaling purposes:

- ☐ Controlling interference.
- ☐ Passing brief information, such as identification and status.
- ☐ Passing large quantities of data.

chosen to support the transmission. Subaudible signaling is too slow; narrowband private land mobile radio FM channels are too narrow to fit out-of-band signaling above the 3,000Hz baseband.

Conventional two-way radio systems must comply with established, stringent RF performance standards. Signaling modulates the signal within the existing framework of operating principles and regulatory specifications, which makes the choice of in-band signaling almost inevitable.

Important characteristics of in-band signaling include:

- *Decode sensitivity*—The signaling

decoder must operate reliably at the lowest possible signal-to-noise ratio. Such operation delivers the highest data throughput, increased reliability, extended range and greatest coverage.

- *Immunity to falsing*—The signaling system must consistently and reliably reject "wrong calls."

- *Signaling speed*—The faster the signaling, the better. Speedy signaling takes the least airtime and disturbs operators less, increasing efficiency.

- *Interference immunity*—The mobile radio environment is hostile. Unwanted interference, co-channel signals, rapid fading and temporary loss of received signal are normal conditions. The sig-

naling system must cope with these effects, which should not cause decode sensitivity loss or lead to increased falsing.

- *Compatibility*—In-band signaling systems usually are installed into existing or new voice communications networks. The signaling system should be compatible and not impose special requirements for distortion, frequency linearity, passband responses and phase delays. The less sensitive the signaling system is to such variables, the more effective it is.

- *Ease of installation*—The best signaling system must be readily installed into a radio. Signaling equipment should be insensitive to decoder input level variations and switching delays.

Many of these characteristics are or may be interdependent. Ultra-high speed does not result in maximum decode sensitivity; minimum occupied bandwidth usually means slower speed.

A signaling system represents a compromise between these characteristics. A satisfactory design is derived from a

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## Signaling types:

- ❑ **Subaudible signaling**—usually used for interference control, some forms of channel trunking control and squelch tail elimination.
- ❑ **In-band signaling**—usually used for data communication. Desirable in-band signaling characteristics include:
  - reliable decode sensitivity at low signal-to-noise ratios.
  - immunity to falsing.
  - high speed.
  - interference immunity.
  - compatibility with existing radio systems.
  - easy installation.

choice of basic operating principles and their implementation.

Many signaling requirements are for "short and sharp" data messages.

Examples include the transmission of a coded identity at the beginning of each

transmission and when another mobile in the network is to be selectively called at the beginning of a conversation.

The system is, and remains, a voice communications system. But the short, transient data messages sent at appropri-

ate times help enormously by eliminating an oral call setup procedure and repeat calls.

Among signaling methods suitable for transient data transfer, five-tone sequential signaling is ideal.

## Five-tone signaling

The five-tone method provides high decode sensitivity. It operates reliably at SINAD ratios where speech communication is impossible. The system is highly immune to RF interference. It passes through transmission paths of widely varying characteristics. It easily is installed in virtually any mobile or portable radio.

The speed of five-tone sequential signaling is relatively high. Currently available five-tone systems operate satisfactorily at tone periods of 20ms, resulting in a code length of 100ms for a full identity message.

Although most five-tone systems use a five-tone format, special applications may use more than five tones to convey additional information such as "canned" status messages or special fleet "flags."

## Continuous data transfer

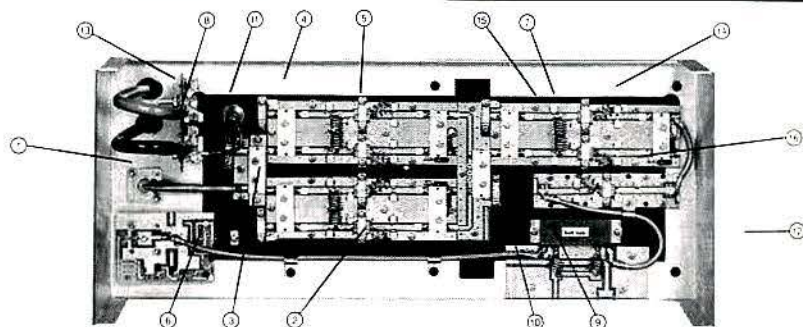
When larger amounts of data are to be transmitted, such as with limited or full text and data to and from a central database, signaling requirements are quite different from those of transient data transfer.

Full data transfer systems almost invariably use high-speed, digitally encoded signaling. Two-tone frequency-shift keying and, to a lesser extent, two-level phase-shift keying, are commonly used techniques. Such systems normally operate at baud rates of 1,200 or higher.

Digital signaling, when properly implemented, is an ideal technique for continuous data transfer. But high speed is achieved at the expense of some of the high-performance advantages of five-tone signaling. Particularly compromised are decode sensitivity and tolerance to transmission path variations.

System frequency response and phase delay requirements specifically are more critical in high-speed digital systems, making the conditions for successful installation into an existing radio system far more demanding than those for a five-tone system.

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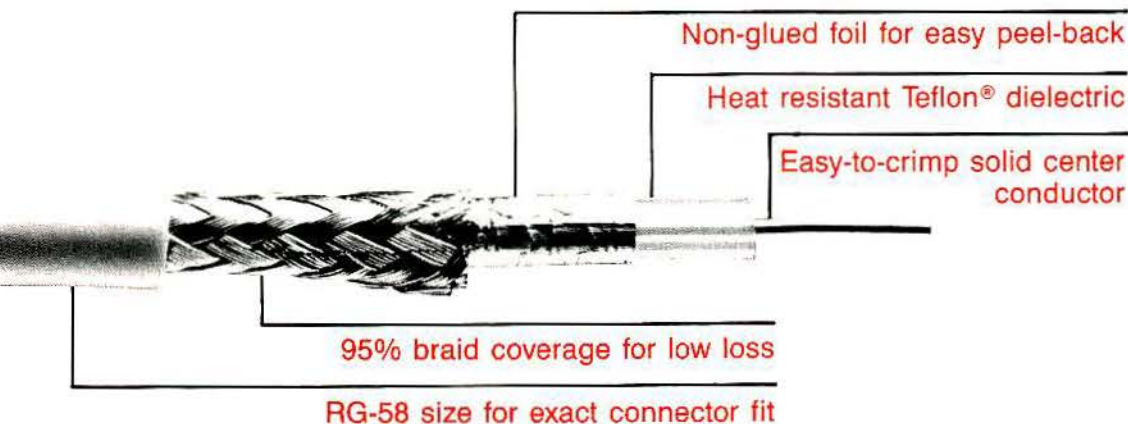
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# Cellular antenna theory with the installer in mind

*Installers who know some antenna theory are in a better position to select models, install antennas and troubleshoot their problems. Much of this information applies to 800MHz/900MHz two-way radio antennas, too.*

By Herb Blaese

All too often, installers are confronted with lists of "do this" and "don't do that," yet they do not understand the reasons behind the recommendations. Without antenna theory knowledge, installers lack pertinent information they need to make appropriate recommendations for a given product.

Installers who know some antenna theory to go with the advice understand cellular antennas better. They are in a position to make more reliable installations.

## Antenna function

The mobile cellular antenna provides the essential communications link between the cell site and the mobile phone installation. The mobile antenna transmits and receives radio energy simultaneously.

Transmission and reception quality and clarity are influenced by several factors.

For example, the mobile antenna's RF emission pattern is intended to be omnidirectional to cover all directions equally, regardless of the vehicle's heading. When mounted on a vehicle in a good location, the antenna's actual emission pattern has the best chance of being omnidirectional.

An antenna with omnidirectional coverage and one that is not too tall restricts a mobile antenna's practical, overall gain. Gain, to put it simply, is an antenna characteristic that focuses the

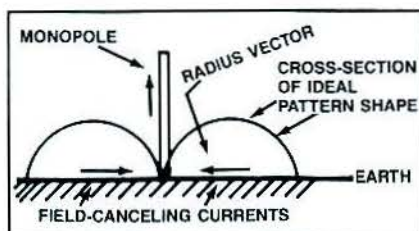


Figure 1. The ideal pattern of a stub antenna at ground level. The length of a 'radius vector' indicates the relative radiation intensity in that direction.

transmitted and received signals, concentrating the energy where it normally does the most good—along the earth's surface.

"Gain" by itself does not tell the whole story of satisfactory reception and transmission. It is necessary to consider an antenna's spatial distribution of transmitted energy. Together with gain, this distribution can determine which antenna will serve a particular application best.

## RF emission patterns

Antenna engineers agree that an antenna's RF emission pattern is influenced by its environment, including the antenna mounting and the surrounding ground. (A little more detail: The RF emission pattern sometimes is called a "radiation" pattern, though in this context it has nothing to do with radioactivity or microwaves. For certain antennas at some frequencies, the ground is the earth. For cellular mobile antennas, the ground is metal, usually the auto body surface near the antenna.)

A monopole (stub or unity-gain) antenna mounted at ground level is a common theoretical reference point for an-

tenna gain and emission pattern discussions. As shown in Figure 1 on the left, a cross-section of the antenna's ideal pattern exhibits a smooth, doughnut-type shape. The "radius vector" length indicates the relative signal intensity in a particular direction.

Maximum signal strength occurs along the earth, toward the horizon. Ideally, only the earth's curvature would limit communication range. In practice, another range limit is the antenna's effective radiated power (ERP), a measure of the transmitted power level as focused in the desired direction.

Mobile antennas, by definition, always are positioned above the earth ground level. Consequently, direct and reflected signals that otherwise would shape the signal into the ideal "doughnut" shape along the horizon become distorted, as well as the pattern. The distortion especially is a problem along the horizon. A serrated pattern with numerous nulls results. (See Figure 2 on page 24.)

A vertical monopole mounted on the center of a vehicle's roof typically exhibits this kind of serrated emission pattern. Its coverage in the vertical plane may be quite wide and tilted upward because of the metallic ground so near it. Therefore, a considerable amount of RF energy may be broadcast at high angles to the earth where it overshoots receiving antennas. A gain antenna, which tends to concentrate RF energy on the horizon, helps to improve the situation.

## Gain antennas

Mobile antenna gain can be increased by stacking multiple elements vertically, one above the other. (The arrange-

Blaese is the chief engineer for Mobile Mark, Schiller Park, IL.



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ment is called "collinear.") Stacking must be done in a way that maintains a proper phase relationship so energy emitted from each of the elements adds together properly. Two stacked elements roughly double the antenna gain. As measured on the decibel scale of power relationships, twice the gain equals 3dB—hence the term, "3dB gain" antennas.

Gain increases because the RF emission is more focused. More energy is concentrated near the horizon, and less power is broadcast at higher angles to the earth.

#### Antenna position

The ideal position for a mobile cellular antenna is at the center of a metal roof. Whether body-mount or glass-mount, an antenna is sensitive to its environment. Thus, the vehicle shape and the antenna's position on the vehicle does, to a certain degree, affect the RF emission pattern. For example, identical antennas mounted on different cars may produce different patterns.

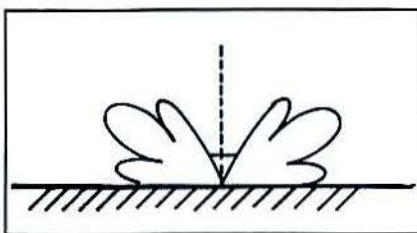


Figure 2. The possible pattern of an elevated antenna. Nulls are caused by direct and reflected waves being out of step with each other.

Commonly, glass-mount antennas affixed near the glass edge along the rooftop outperform body-mount antennas placed lower on the vehicle. To cover all directions, the antenna should be mounted high on the vehicle.

A common misconception about glass-mount antennas is that the energy they transfer from the coaxial cable through the glass to the antenna base is substantially weakened in the process. Instead, the glass is a *transmission medium*. With a well-designed glass-mount antenna, a negligible amount of

RF energy is lost as it passes through the glass. That is why it is not necessary to drill a hole in the glass to connect the cable directly to the antenna base.

#### Antenna designs

"Voltage-fed" and "current-fed" are names for two types of glass-mount antennas. The names refer to the distribution of energy on the antenna and the characteristic of that energy at the base of the antenna.

When electromagnetic radio waves from a distant transmitter flow past an antenna, they cause minute electrical currents waves to flow in the antenna. These electrical currents are carried by the coax to the receiver, where they are converted into sound and other forms of communication. Conversely, RF energy from the transmitter is carried in the form of electrical current by coax to the antenna. Oscillations of the electrical current in the antenna generate radio waves that leave the antenna and travel to a distant receiver.

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Electrical wave oscillations in a properly tuned antenna become "standing waves." If they could be seen, they would appear to be motionless. Actually, they are oscillating in perfect harmony, or *resonance*.

Two components of these electrical standing waves are not in harmony, though. When the voltage component of the wave is at its maximum, the current component is at its minimum, and vice versa.

If the antenna is designed so the electrical wave enters its base with current at a maximum, it is called a current-fed antenna. If it is designed so the electrical wave enters its base with voltage at a maximum, it is called a voltage-fed antenna. Each design has its advantages and disadvantages.

### Impedance matching

Maximum energy transfers between one electrical device and another when their impedances are matched. For example, a 4Ω stereo amplifier works best with 4Ω speakers, not 16Ω speakers.

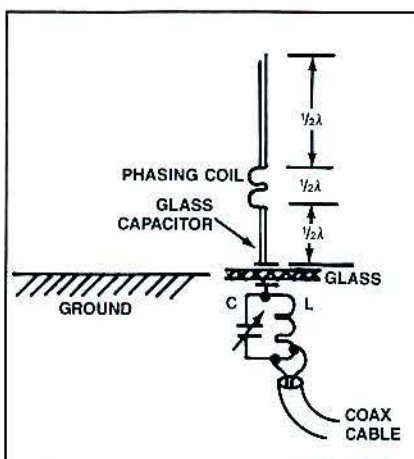


Figure 3. The configuration of a popular 3dB on-glass antenna.

An antenna may be designed to take advantage of certain vertical element lengths and phasing coil positions and, as a result, exhibits the characteristic of a voltage-fed antenna. Another design may result in a current-fed antenna.

Both antennas are fed with 50Ω coaxial cable because 50Ω has become the

standard impedance for cable used in virtually all cellular phone and two-way radio installations. The impedance at the base of a voltage-fed antenna is much higher than 50Ω. Thus, a circuit that forms an impedance-matching transformer is placed at the base of a voltage-fed antenna to match the impedance of the 50Ω coax. The impedance at the base of a current-fed antenna normally is much closer to 50Ω, so no transformer is required.

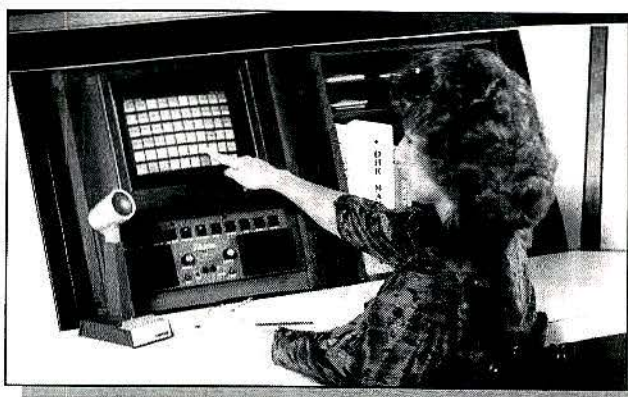
Most voltage-fed antennas' impedance-matching circuits are tunable for the best match. The adjustment is made at the factory or by the installer.

Most current-fed antennas require no adjustment.

### Voltage-fed antenna

Voltage-fed antennas usually have smaller mounting feet than current-fed antennas because metal plates within the feet form capacitors that transfer the RF energy through the glass. Current-fed antennas require larger capacitors than voltage-fed antennas.

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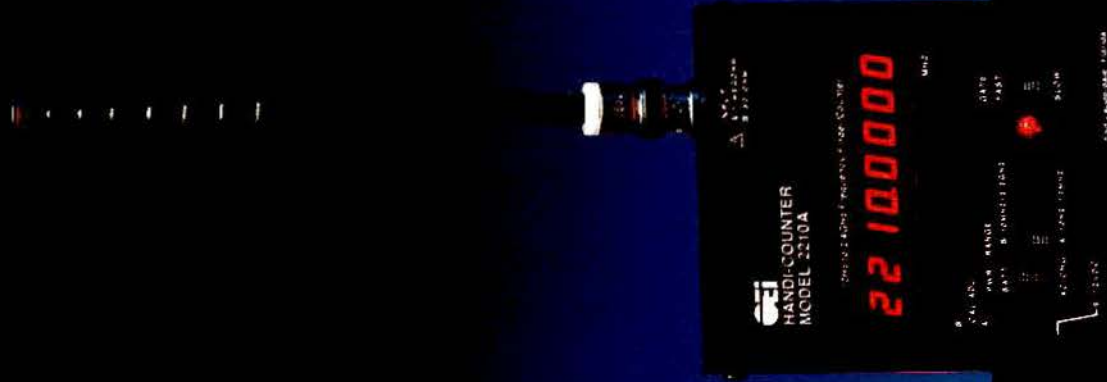
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# OPTOELECTRONICS



A popular type of voltage-fed mobile antenna is the 3dB gain glass-mount. Shown as an electrical diagram in Figure 3 on page 26, the antenna consists of inductance  $L$  and capacitance  $C$ . The resonance of the antenna, meaning the frequency at which it works best, is adjusted by changing the values of  $L$ ,  $C$  or both.

By way of analogy, the audio frequen-

cy at which a violin string resonates and for which it produces sound when it vibrates is adjusted by changing its thickness, tension or both. To tune a violin string, it is more convenient to adjust its tension. Similarly, to tune a glass-mount cellular antenna, it is more convenient to adjust its capacitance.

The antenna's capacitor is adjusted so that the antenna's resonant frequency

corresponds to the particular cellular frequency being used. The antenna's vertical element also resonates at this frequency. RF energy is fed via the coaxial cable through an impedance-matching tap on the  $L$ - $C$  tuned circuit. The impedance at the top of the tuned circuit is relatively high (voltage node) compared to the impedance of the coaxial cable.

The antenna itself is a stack of two halfwave monopoles separated by a phasing coil and fed through the glass at the bottom, as illustrated in Figure 3. Each halfwave element contributes to the strength and focus (gain) of the signal emitted by the antenna, increasing the gain by two times (3dB). The elevation of the signal above the horizon is reduced, so signal strength near the horizon increases.

To compensate for the effect of through-glass capacity, the lower half-wave element shown in Figure 3 physically is shorter than the top section. The

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*Voltage-fed antennas are more sensitive to environmental changes.*

through-glass capacity is called capacitive loading. It is a consequence of the voltage-fed design.

The variable capacitor  $C$  must be adjusted carefully so that the  $L$ - $C$  tuned circuit, including the glass capacity, resonates at the center of the cellular frequency band. Otherwise, some of the available transmitter power may not transfer through the glass.

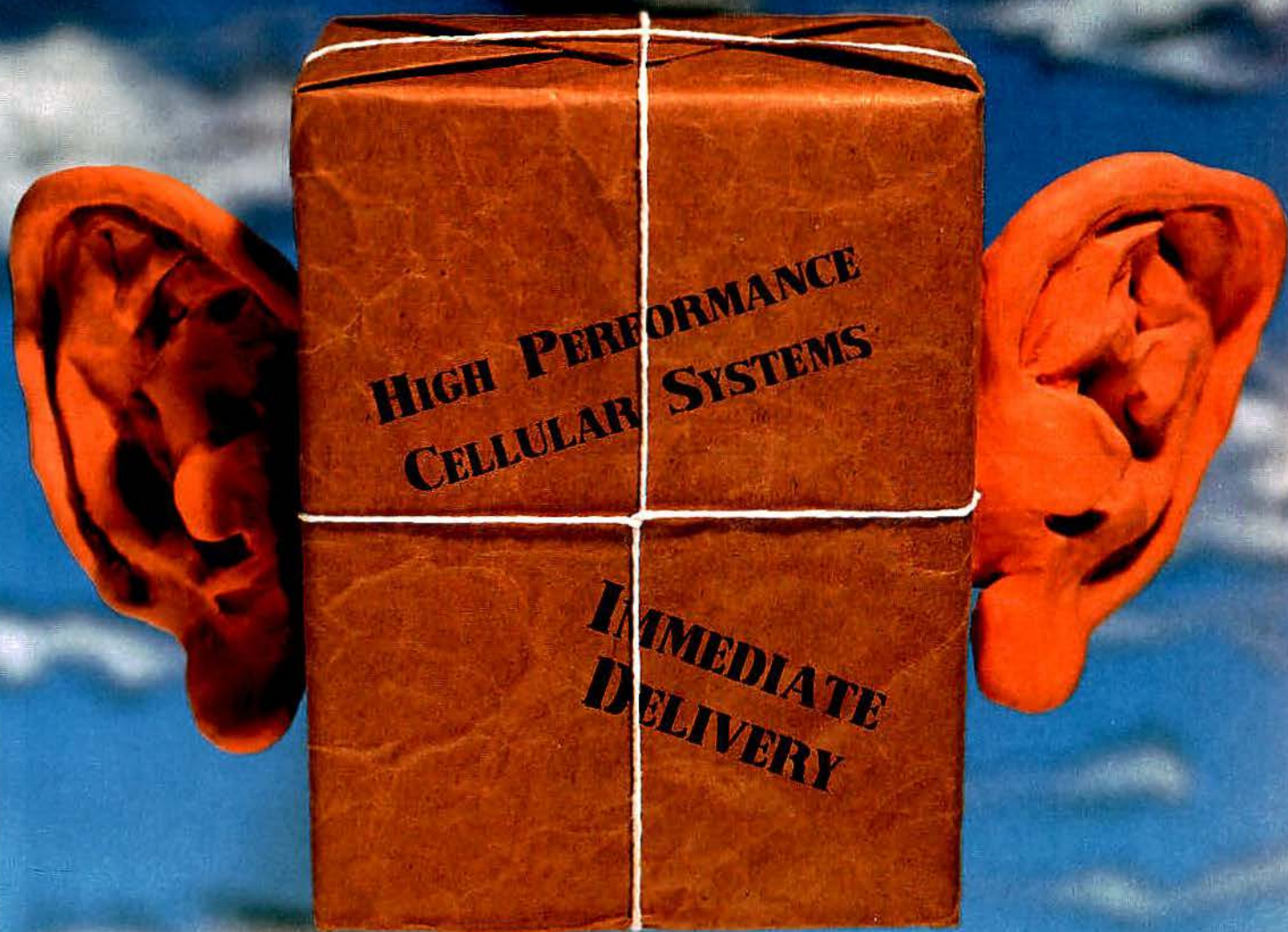
Voltage-fed antennas are more sensitive to environmental changes. Snow, ice or slush buildup on the window may reduce a voltage-fed antenna's performance temporarily by detuning the  $L$ - $C$  loading circuit alignment.

### Current-fed antennas

The current-fed antenna takes advantage of the fact that the impedance at its base, approximately  $50\Omega$ , closely



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matches impedance of the coaxial cable. With this design, there is no need to transform the impedance between the antenna base and the coax, so a matching network or a tuning adjustment box is not needed. Figure 4 on the right shows the current distribution on a typical current-fed 3dB gain mobile antenna. Note that the currents flowing on the conductors on the inside of the glass oppose each other. They are referred to as field-canceling currents.

Because the current-fed antenna's mounting base meets the glass where the electrical wave has maximum current and minimum voltage, the lengths of the antenna's vertical elements differ from those of the voltage-fed antenna. The vertical part of the antenna in Figure 4 is  $5/8$ - (0.625) wavelength long. The so-called non-fading range of a vertical antenna is greatest when its length is 0.64 wavelength, that is, an antenna extending about  $5/8$  wavelength long produces the strongest signal along the ground.

As with any type of mobile antenna,

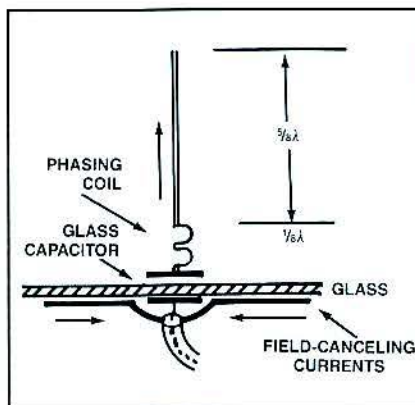


Figure 4. OW-3-900 3dB gain on-glass antenna.

the surrounding environment influences the RF emission pattern. Because the 3dB gain current-fed antenna produces a stronger signal near the ground, it performs well under difficult conditions.

The feedpoint on a current-fed antenna is at a voltage minimum; therefore, the antenna is less sensitive to snow, ice and dirt that may build up near its mount.

Figure 5 on page 32 shows the typical construction of a 5dB gain current-fed antenna. It consists of a collinear stack of a  $5/8$ -wave and a  $3/8$ -wave element separated by a quarterwave phasing coil. The center-to-center spacing between the two elements is  $3/4$  wavelength, which provides superior gain.

### The 5dB gain antenna

The typical RF emission pattern of a 5dB gain antenna is narrower in the vertical plane and longer in the horizontal plane than the 3dB gain antenna's pattern.

By way of analogy, picture an air-filled balloon. Without changing the amount of air in the balloon, its shape can be changed dramatically. When a balloon on a tabletop is pressed down upon from above, it flattens and extends to the sides.

The shape of the 3dB gain antenna's emission pattern resembles a doughnut. The 5dB gain antenna's pattern might be pictured as a flattened doughnut "balloon," with the signal extending further

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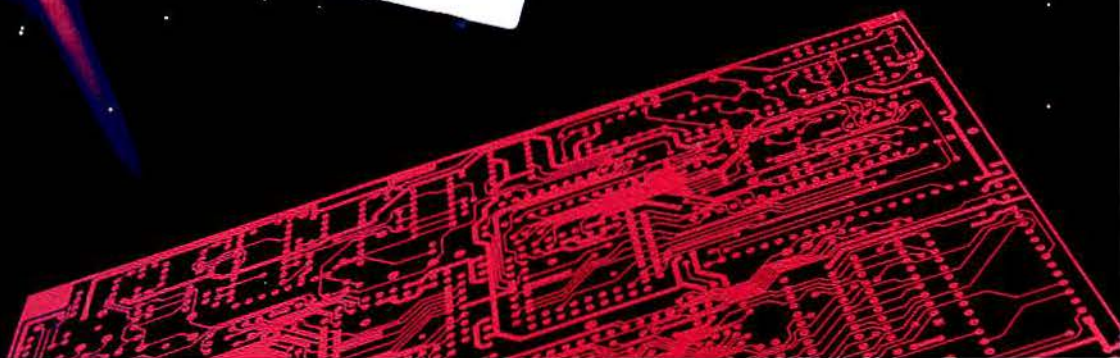
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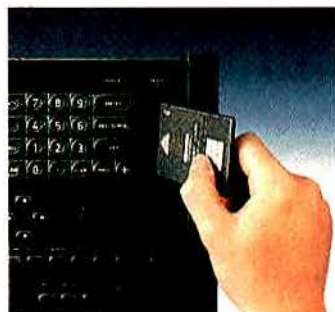
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along the ground than the signal from the 3dB gain antenna's signal.

Although the 5dB gain antenna's extension of signal range may be an advantage, when the whip flexes in windy conditions or as air flows past it when the vehicle on which it is mounted is driven fast, the flexing may cause the signal pattern alternately to rise above and fall below its intended target. The resulting fading may offset the signal improvement offered by the increased gain.

#### 5dB gain applications

The 5dB gain antenna can provide greater signal strength on the horizon than either the stub or 3dB gain units. This characteristic may be valuable in fringe-area reception where the stronger signal extends operating range.

Although many people believe "the more gain the better," there may be situations in which the use of a 5dB gain antenna amounts to overkill. Moreover, there remains some concern in the cellular community over the possibility that

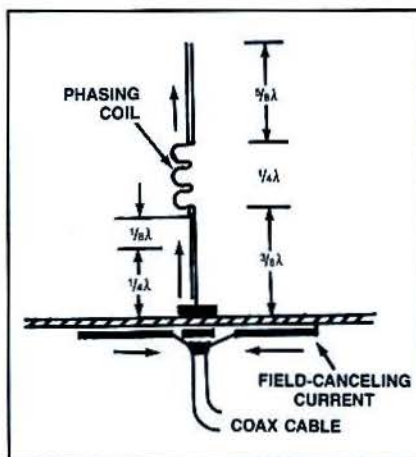


Figure 5. The construction of a 5dB gain current-fed antenna.

intermodulation distortion may be generated when the 5dB mobile antenna is used close to a cell site. Although this might happen if the feedback channel were incapable of reducing the ERP sufficiently, this is unlikely to happen in most systems operational today.

In mature cellular systems, the receive-

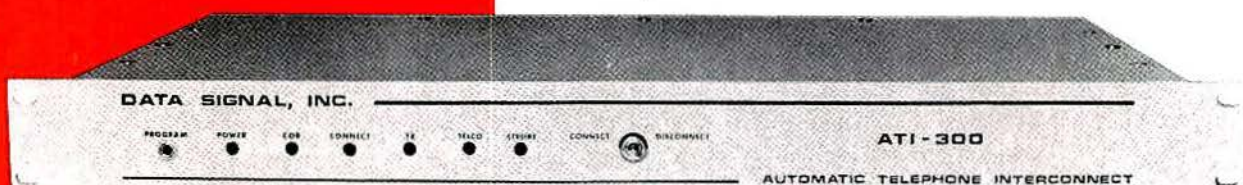
er at the cell site is designed to lower the received signal level automatically if the ERP from the mobile antenna is greater than what is needed to communicate. In a sense, this means that the 5dB antenna operates at the same effective power level as a lower-gain antenna until it is called upon to generate more power.

With this point in mind, it could be worthwhile to install the 5dB gain antenna for users who travel in fringes of the cellular coverage area or in areas with spotty coverage. Nevertheless, users and installers must keep in mind the importance of maintaining the antenna in a fully vertical position. The 5dB gain antenna, with its narrower beam in the vertical plane, is at greater risk of having its effective operating gain reduced by position shifts.

Other 5dB gain antenna applications make good sense, too. One is for a hand-held unit in the vehicle, plugged into either a permanently installed or portable 5dB gain antenna. This operation avoids the frustrating dropouts of hand-

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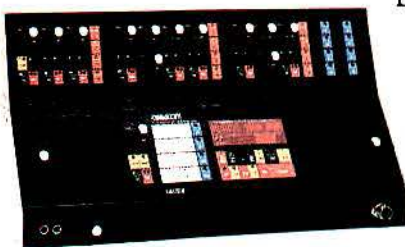
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### Check the following:

- ☐ Is the antenna completely vertical?
- ☐ Is the antenna whip removable?
- ☐ Is the antenna properly matched to the coaxial cable?
- ☐ Have fittings been applied correctly to the coaxial cable?
- ☐ Has the excess cable been removed?
- ☐ Is the antenna positioned as high as possible and in close proximity to the metal roof?
- ☐ Is the transfer plate on the antenna base correctly positioned above or between defroster wires?

holds that are common to inside-the-vehicle use. The dropouts are caused because the vehicle's surrounding metal body causes frequent shadowing of the signal from the cell site. In this case, with 15 feet of RG-58 cable, the ERP would be approximately 2.5W. In a cellular system with plenty of cell sites (a "mature cellular environment"), this arrangement would prove entirely satisfactory.

#### Putting it into practice

When customers complain of inade-

quate coverage, check the following:

- Is the antenna completely vertical? Some antennas tend to tip toward the horizontal. When the antenna tips, performance deteriorates, especially if the antenna has high gain.
- Is the antenna whip removable? Repeated removal and reattachment (to avoid theft and to prevent damage from car washes) causes wear and tear on the connector's conductive surfaces.
- Is the antenna properly matched to the coaxial cable? Some antennas, especially those with tuning boxes, are

prone to becoming misaligned; performance deteriorates as they drift out of tune. This problem can be detected and measured with a reflected-power meter or a combination directional coupler and power meter. Either instrument can be used to measure how much RF power is being reflected from the antenna feedpoint because of a mismatch between the cable and the feedpoint.

- Have fittings been applied correctly to the coaxial cable? Ohmmeter measurements reveal open and shorted connectors.

- Has the excess cable been removed? Coaxial cable loss approximates 23dB/100 feet at 900MHz. More than half of the transmitter power can be lost in 15 feet of RG-58 cable commonly used in mobile installations. The receiver may receive only about 60% of the available signal. Thus, the cable should be cut to the required length, rather than coiling the excess.

- Is the antenna positioned as high as possible on the car and in close proximity to the metal roof? If the rear window is low on the car and the antenna will not clear the roof line, consider installing the antenna on the front window.

- Is the transfer plate on the antenna base correctly positioned above or between defroster wires? If the transfer plate falls on the defroster wires, the defroster circuit may interfere with reception.

- Are factors present that prohibit glass mounting? For example, antennas should not be mounted on pyrolytic glass or glass with a baked-on conductive coating that turns the glass into a one-way window. On the other hand, tinted glass usually is tinted with plastic overlays that have little, if any, affect on glass-mount antenna performance.

#### Judge for yourself

This overview of antenna theory covers several cellular mobile antennas, including the reference monopole, 3dB gain and 5dB gain antennas. The next time you are confronted with a list of "do this" or "don't do that," you will be able to judge for yourself the value of the advice.



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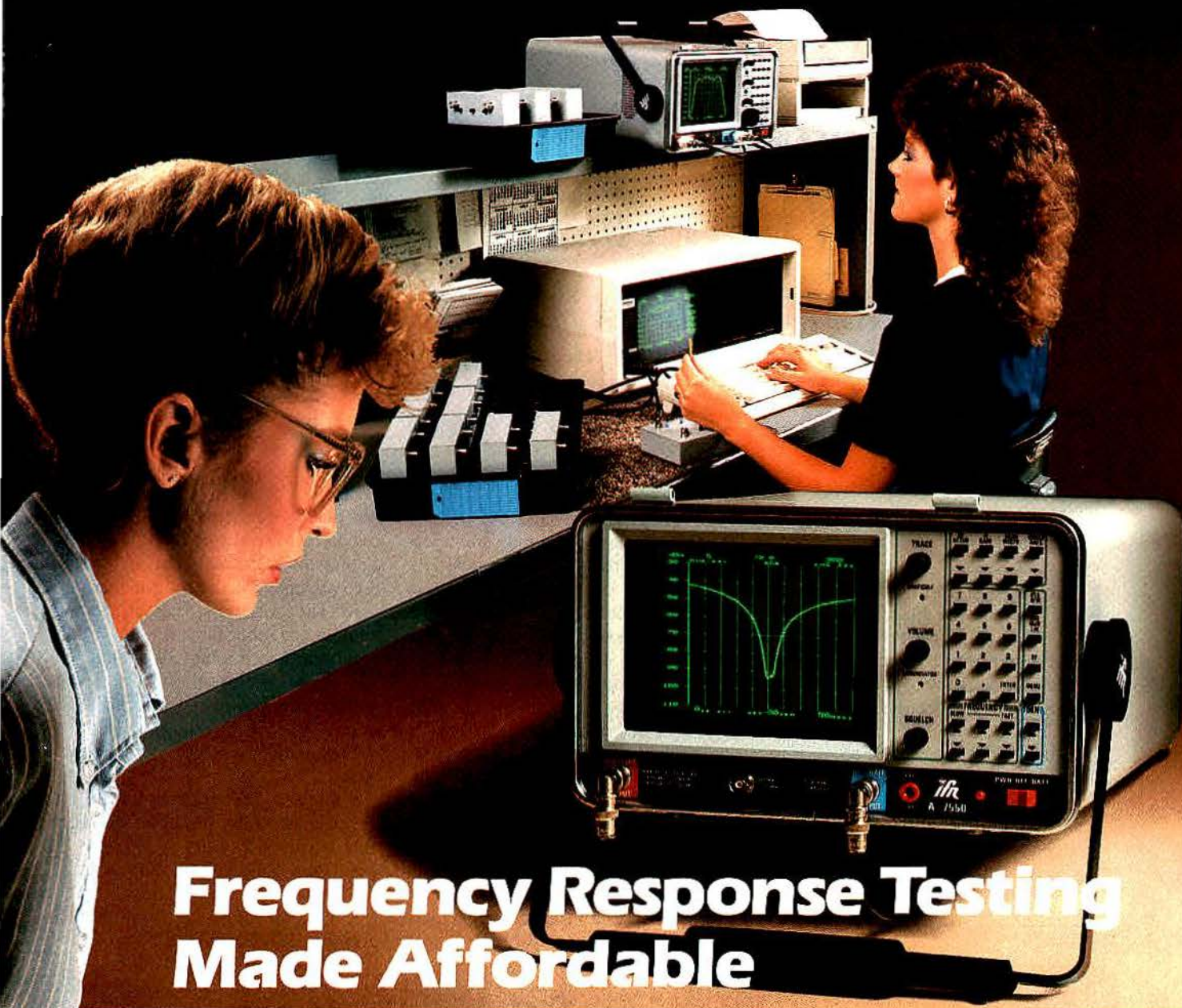
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# Low-gain cellular antennas: When *less is more*

*As cell-site concentrations increase, the need for high-gain antennas on mobile units diminishes. Continued use of gain antennas may cause service interruptions, disrupt system operations and reduce system reliability.*

By Gershon Cooper

America has a love affair with anything big, and the adage, "the bigger, the better," rings true for most people. A car with a huge engine is considered better than a car with a small engine. A large house is deemed better than a little house.

When cellular mobile telephone communication was conceived, the idea was to use low-power mobile transceivers and multiple, small coverage areas—cells—to serve large areas. Although

many people understand the cellular concept, a few, including some engineers, manufacturers, dealers and subscribers, are obsessed with the adage, "the bigger, the better." A 3W cellular set is better than a 1.2W unit, they believe. A 0.6W hand-held will not provide the same quality service as a 1.2W, they think. By the same token, when high-gain cellular antennas arrived in the market, people rushed to purchase them without fully understanding the conditions under which these high-gain antennas would improve service quality.

The cellular receiver is a sophisticated piece of equipment. It integrates computing systems with communications at high radio frequencies that are

not clearly understood. The cellular transceiver is controlled by the cell and a computer at the main switching office over a channel dedicated for that purpose. The unit's power output, channel number and other functions are strictly regulated. The standard 3W mobile unit has eight different power levels representing power reductions in 4dB steps.

Maximum power levels are designated as:

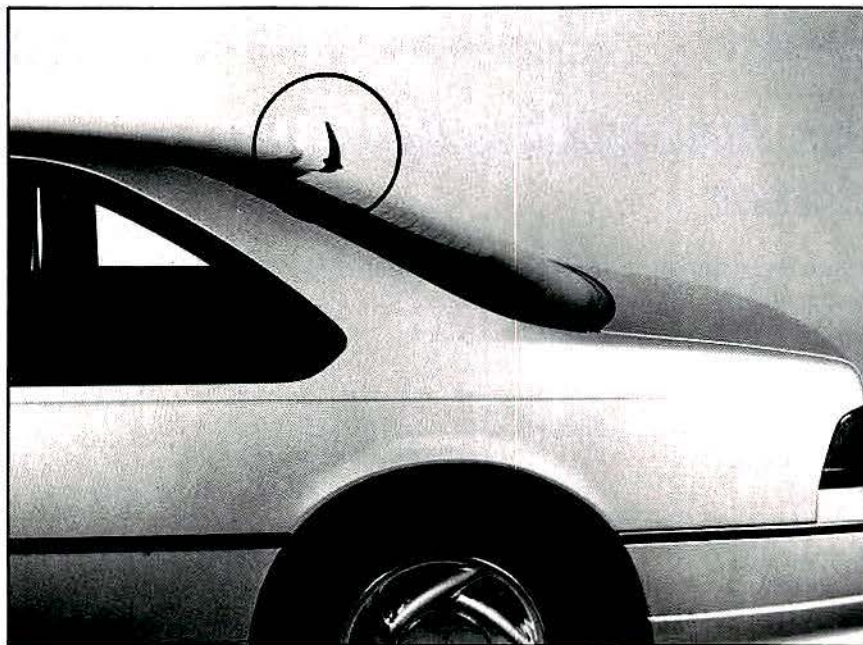
- Class 0—3W (mobile unit).
- Class 1—1.2W (usually a transportable unit).
- Class 2—0.6W (usually a hand-held unit).

The mobile unit's eight power levels are: 3W, 1.2W, 0.48W, 0.19W, 0.075W, 0.030W, 0.012W and 0.0048W.

Automatic control signals from the cell site constantly vary a mobile unit's output power according to the received signal strength at the cell site. In an area with few cell sites, the mobile unit's power level increases as its distance to the nearest cell site increases. As the mobile unit approaches the cell site with which it is in communication, the cell site reduces the mobile unit's output power.

In an area with closely spaced cell sites, the mobile unit always is within a short distance of the cell. In such an area, the mobile unit output power seldom exceeds 0.19W.

Cellular telephone retailers initially compensated for a lack of closely spaced cell sites by installing high-gain antennas that extend the mobile unit's range. The FCC allows a maximum power output of 3W and an effective radiated power (ERP) of 7W, so the collinear (mono-



An example of a glass-mount unity gain mobile antenna.



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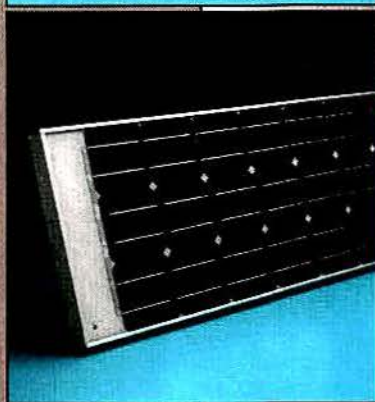
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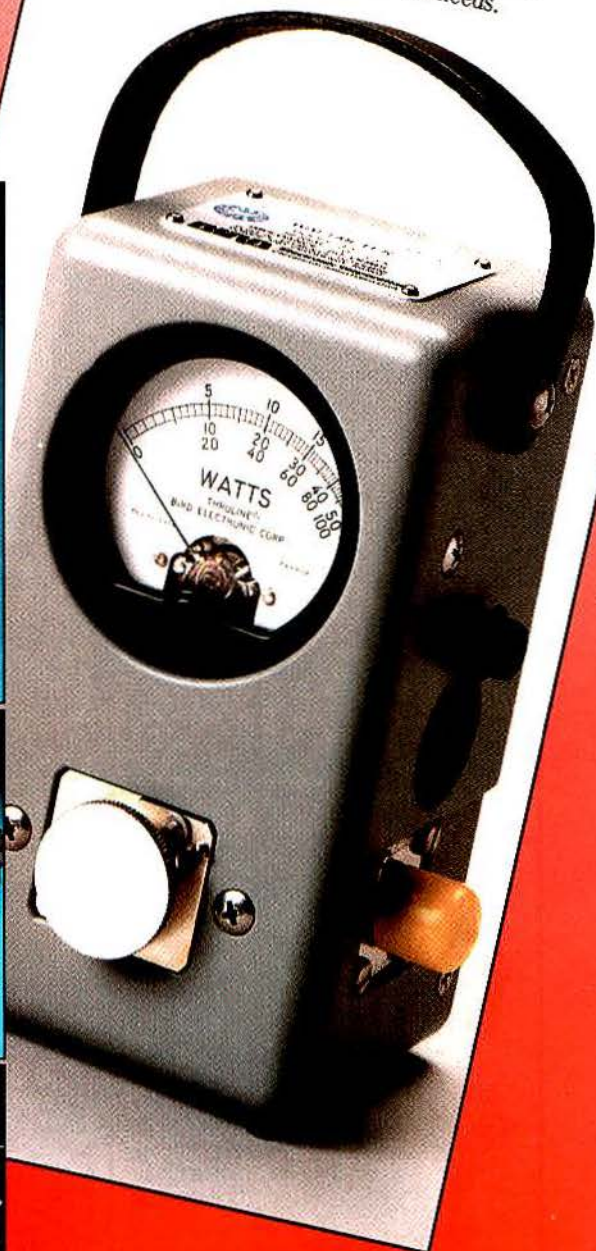
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pole) 3dB gain antenna became an unofficial standard. The 3dB antenna offered a maximum 6W ERP.

To the consumer, the 3dB gain whip antenna with a spring in the middle became synonymous with cellular telephone. Several manufacturers that introduced 3dB gain antennas with an enclosed coil that prevents wind noise and that introduced a simple linear design found them difficult to sell.

#### High-gain cellular antennas

As cellular telephone use increased, new antennas for specific applications were introduced. Among the first of these was the 5dB gain antenna, which was designed to improve the performance of low-power units operating in fringe areas. Its purpose was to compensate for transmission line losses and less-than-perfect installations.

Higher-gain antennas, such as the 5dB model, have been credited with talk time gains for transportable and portable units because less output power for the same signal level means less power con-

sumption. They have been credited with maintaining communications where cell sites otherwise are too far apart, and

*...it is likely that the market will be divided between 5dB high-gain antennas in open, rural areas and unity-gain antennas in metropolitan areas.*

with overcoming the losses in long transmission lines.

On the other hand, high-gain antennas do not work well in areas with dense

cell site concentrations. Because of FM's "capture effect," the phone call is not handed off, as it should be, to the nearest cell site as the mobile travels through the area.

The conventional 3dB gain antenna does not work much better in such areas. It causes the same undesirable effects as the 5dB antenna.

The solution has been to switch to non-gain antennas for use in areas with concentrated cell sites.

#### Non-gain cellular antennas

In England, the cellular system was built first and put into service second. This meant that there were enough cell sites for adequate service on the first day of operation. Not surprisingly, therefore, the most popular antennas for vehicular use in the United Kingdom are unity gain, wideband antennas. High-gain antennas never gained popularity because they simply were not needed.

In the United States, unity-gain antennas, also known as low-gain or non-gain antennas, have been available from several manufacturers.

Some models were adapted from UHF two-way radio antennas designed for limited bandwidth, although U.S. cellular systems require at least 70MHz bandwidth. A simple quarterwave ground plane antenna has a narrow bandwidth. Even the available collinear antennas were designed for gain, rather than bandwidth.

Several companies offer workable unity gain antennas. To achieve the required bandwidth, the antennas use dual masts and large-diameter conductors, among other methods. The antennas come in body-mount and glass-mount models. Their use solves many of the carrier's service problems. The antennas help the carrier to improve system operation, to reduce service interruptions and to maintain the system's level of reliability.

It is doubtful that unity-gain antennas will replace high-gain antennas completely in the U.S. market. Unlike the United Kingdom, the United States still has vast open areas without dense cell-site coverage, so high-gain antennas still will be required in some areas. But it is likely that the market will be divided between 5dB high-gain antennas in open, rural areas and unity-gain antennas in metropolitan areas.

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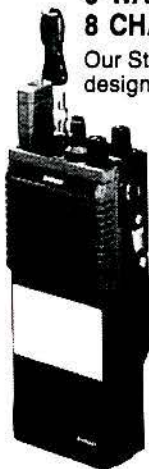
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As a result, most SMR's have seen new growth above and beyond their wildest five-channel dreams. Now it's a 10, 15, and even 20 channel world.

So, Hark has expanded their interface technology -- introducing the SI-550 EX -- to accommodate SMR's with big plans to grow. Really big plans. Of course, the original SI-550 is still available -- a trusty work horse for SMR's with good reason to be small.

But if your long-range blueprints call for new growth, big changes, maybe even resale or merger -- remember Hark's latest interface solution is the SI-550 EX. Hey, change happens.

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## Glenayre hikes stake in Kustom

Glenayre Electronics, Vancouver, British Columbia, has increased its holdings in Kustom Electronics, Overland Park, KS. Glenayre is the majority shareholder in Kustom and purchased 46,100 more shares of common stock between \$4.09 and \$3.85 per share from Sept. 4 to Sept. 28.

Glenayre now holds 1.408 million common shares worth around \$5.1 million. Glenayre owns more than 70% of Kustom's outstanding shares.

## ElectroCom consolidates telecommunications group

ElectroCom Automation, Arlington, TX, has consolidated its telecommunications group and moved it to Los Angeles. August Schellhammer serves as vice president of the new group.

The telecommunications group includes Telecommunications Systems, Digicom Products and Console Systems.

## Johnson secures patent for power source technology

E. F. Johnson, Waseca, MN, has received a patent on its power source technology that generates continuous, low-power electrical energy. A light-emitting polymer, coupled with solar-type cells, generates electricity. The technology is suited for uses that require energy of a low-power, long-life battery and freedom from corrosive chemicals.

The technology still is in development.

## Telocator advocates expedient action on PCS

Telocator, Washington, DC, has pressed the FCC to decide quickly on allocating spectrum for personal communications services (PCS) and to establish PCS service providers as common carriers rather than private carriers.

Representing paging and cellular carriers, the association opposed using an advanced paging allocation of 930MHz to 931MHz for PCS.

tal stages and will not be available from the company for commercial use for several years. All indicators on the power source indicate it will produce continuous electricity for more than 25 years.

The company said the power source can be produced in various sizes and can be made quite small.

## Study: 40% of households to subscribe to PCS

According to an Arthur D. Little study conducted on Millicom's behalf, as many as 40% of U.S. households are expected to subscribe to personal communications services (PCS). Data show a wide variety of interest in the services from all segments.

Businesses also are likely to be major subscribers to PCS. More than one in three companies will buy the services, the study shows.

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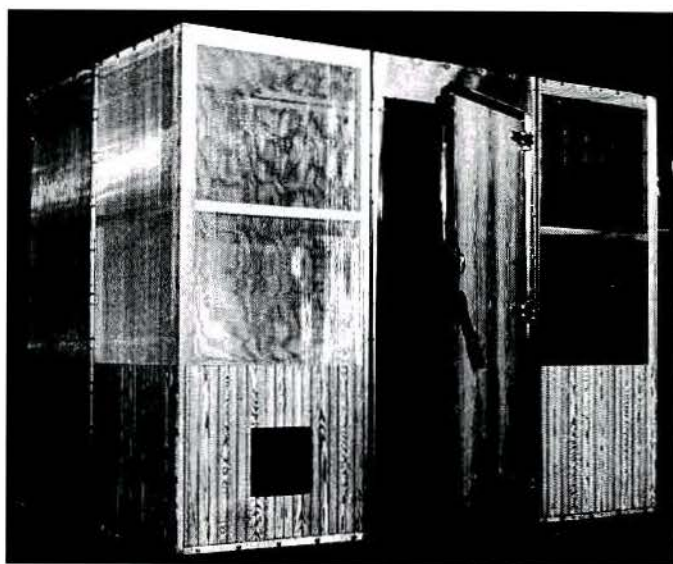
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## Ericsson Paging commences promotional program

Ericsson Paging Systems, Greenwich, CT, and Time Design Systems of California have established a joint promotional program in which Ericsson's Axxess pager will be promoted to the Time Design clients. The time management planner's client base is more

than 100,000 subscribers.

As part of the promotion, American Paging Systems, Minneapolis, is introducing the Axxess pagers to two of its markets: Phoenix and San Antonio, TX. The promotional program will expand to other markets later in 1990.

## NewVector activates system to send alerts to subscribers

NewVector has installed and started using the IntelliPage made by Real Time Strategies, Hicksville, NY. The call processing device enables NewVector to

forward radio page alerts that indicate messages are awaiting retrieval in voice mailboxes to cellular telephone and other subscribers.

## IMM garners contract for digital mobile radio

International Mobile Machines (IMM), King of Prussia, PA, has sold an Ultraphone mobile radio system to Dell Telephone Cooperative, which serves west Texas and New Mexico.

The IMM wireless telephone network incorporates time division multiple ac-

cess (TDMA) to allow telephone companies to offer subscribers digital mobile service. The Ultraphone cells spans 4,400 square miles and can operate on the Basic Exchange Telecommunications Radio services (BETRS) under a recent FCC decision.

## Glenayre secures contract for Ameritech paging system

Glenayre Electronics, Vancouver, British Columbia, has been awarded a contract to supply GL 3000XL radio paging terminal equipment and SimulComm RF transmitters to Ameritech Mobile Communications, Schaumburg, IL.

The paging terminal equipment will provide enhanced radio paging services such as voice mail, custom prompting and alphanumeric display to Ameritech customers. The SimulComm transmitters will supply automatic optimization of the radio transmitter system for simulcast paging.

## Antenex names distributor

Antenex, Wood Dale, IL, has selected Radio Communications Wholesalers as a distributor. The distributor stocks the company's antenna products for same-day shipment. The distributor is at 816 W. 77 1/2 St., Richfield, MN 55423; phone: 800-726-9015.



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## DAPA to provide antennas for '92 Winter Olympics

DAPA Communications, Allegany, NY, designed, manufactured and installed cellular antennas at 10 stations for the 1992 Winter Olympics. The coverage area incorporates the French Alps, a harsh environment with routine

high winds. The installed units are safeguarded with grounding rods atop the antennas and wired to the ground. The antennas include a 10-year guarantee against lightning, corrosion and interference.

## Study outlines potential of CT2 in top 100 markets

The five-year market potential for CT2 (the "second-generation" cordless telephone) in the top 100 U.S. markets is between 1.3 million and 4 million subscribers, according to Economic and Management Consultants International, Washington, DC. The report indicates CT2 demand will be similar to cellular if it is priced 40% below cellular.

## Centel Cellular experiments with narrowband channel

Centel Cellular, Chicago, is field-testing a narrowband channel technique for cellular call handling. The Motorola method, called Narrow Advanced Mobile Phone Service Standard, reduces the RF spectrum needed for cellular calls and increases call handling capabilities.

## ISCET names chairman, expands member benefits

The International Society of Certified Electronics Technicians (ISCET), Fort Worth, TX, has expanded its range of membership benefits to include discounts on purchased products and professional aids. The association re-elected Leonard Bowdre, CET, technical instructor and former technician and dealer from Des Moines, IA, as its chairman.

## CPI picks distributor

CPI Communications, Richardson, TX, named Cartwright Communication, Cincinnati, as a nationwide distributor for its dc and tone remote controls, termination panels, and encoders and decoders.



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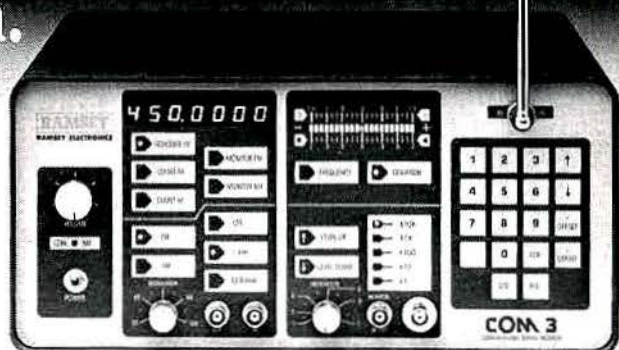
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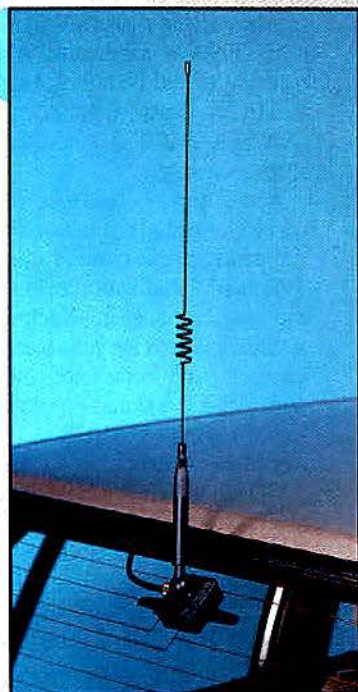
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## Technicians and dealers may find help in 'job bank'

Members of the Association of Communications Technicians (ACT) volunteer leadership council assembled in October 1990 in connection with the Fall meeting of the National Association of Business and Educational Radio (NABER). ACT is a NABER membership section.

According to NABER membership services manager Danielle Poux, one of the projects the council discussed is a "job bank" that would help two-way radio dealers seeking technicians and technicians seeking jobs learn about one another. She contrasted the job bank with job referral and employment services, saying NABER's involvement would be indirect.

"The job bank would involve using our newsletters, *TechTalk* and *Shoptalk*," she explained. "It could take the form of a printed paragraph or a form soliciting information from technicians and dealers. The dealers' information would be published in *TechTalk* and the tech-

nicians' information would be published in *Shoptalk*."

Poux said the council discussed the possibility of initiating regional chapters. "We cannot start formal chapters immediately," she said. "It would take

a year to organize chapters formally, to write charters and to resolve liability matters. So we are beginning with informal regional groups."

Two council members who live in the St. Louis area, Steve Ambo and Thomas Green, have begun organizing an informal chapter for members in Illinois and Missouri. Another chapter is said to be starting in California. Council chairman Ian Wright said: "It seems to be an idea whose time may have come."

Wright went on to say the council had heard few negative comments about dues increases for ACT membership. "There has been no significant drop in membership rate as a result of the increases," he said.

The council discussed the possibility that membership might be reduced as a result of corporate consolidations that may reduce the number of technicians in the field. "We cannot draw a conclusion about it at this time," Wright said.



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## 'Dingell Bill' for reallocation of 200MHz of radio spectrum offers promise, whether enacted into law or not

Legislation introduced into Congress by Rep. John Dingell (D-MI) proposes to take 200MHz of radio spectrum from the federal government allocation and reallocate it to the private sector on the grounds that the government is either not using it or not using it efficiently. The bill, HR 2965, is known as the "Dingell Bill."

According to Clifford Bean, a director of Arthur D. Little, a Cambridge, MA, consulting business, congressional staff view the federal government as wasteful users of radio spectrum. Speaking at a meeting of the National Association of Business and Educational Radio, Bean told an audience: "If all the 200MHz of spectrum were allocated to land mobile uses, it would double the amount of spectrum presently allocated to the land mobile industry. That represents an enormous capacity in-

crease that would open up all kinds of opportunities, *if* allocated to land mobile."

He said there are many competitors for the 200MHz of spectrum, offset by considerable resentment on the part of federal officials who oppose the reallocation of that much spectrum. "We know that the Department of Defense is going to resist strongly the reallocation of any of its spectrum. This matter may drag on for many years before any significant reallocations take place."

Interviews that Arthur D. Little staff members have conducted among congressional staff indicate "the bill is intended to stimulate new technology initiatives—new spectrum-efficient technology initiatives—and not necessarily to provide new allocations to existing services that are providing plain old 'vanilla' radio services. We can expect

to see legislation that will encourage use of this spectrum reallocation to enhance our global competitiveness and introduce valuable new services to the American public."

Bean said authority for the government to auction radio spectrum is explicitly excluded in the bill "in spite of the tremendous temptation in Congress and the rest of the federal government to use the auction to relieve budget pressures within the federal government."

He said lotteries generally are considered on the Hill as not being an efficient way of granting licenses. "So we may see in the enactment of this bill that some important compromises will be reached. We may see a lesser amount of reallocated spectrum coming out of the bill once it is passed," he said.



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## Readers' choice

Of all the new products and services covered in the May 1990 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number found in the back of this issue and mail the card to us.

## Rugged hand-held boasts 200-channel operation

The HX440 synthesized hand-held from **Standard Communications** offers 200-channel operation and a multigrouping feature that allows scanning and user channel selection. The



portable meets military specifications and can be used in most hazardous environments. The unit includes CTCSS signaling; DCS digital private squelch; built-in autodial pad; alphanumeric LCD display; die-cast frame; battery-status indicator; and DTMF-ANI encoder. Busy-channel lockout is available on the carrier, CTCSS or DCS. The radio is 5W or 2W selectable; pc programmable; and one-to-one clonable.

Circle (515) on Fast Fact Card

## Trunked hand-held boasts fail-safe backup system



The M-PA<sup>PLUS</sup> portable from **Ericsson GE Mobile Communications** meets or exceeds APCO specifications for digital trunking. It includes a fail-safe backup system and is field-programmable for customized user requirements. It meets military standards 810C and D. Features include out-of-range indicator, individual message indicator, conventional channel and special call indicators.

Circle (514) on Fast Fact Card

## 16-channel portable includes top-mounted rotary controls



The 16-channel MTL portable offers a wideband frequency range with field-programmable functions such as transmit power, frequency and carrier control timer. The **Ericsson GE Mobile Communications** radio has an environmentally sealed aluminum frame, PTT and 1,200mAh battery. Rotary controls are top-mounted.

Circle (516) on Fast Fact Card



# MAGELLAN PUTS AFFORDABLE GPS TECHNOLOGY AT YOUR FINGERTIPS.

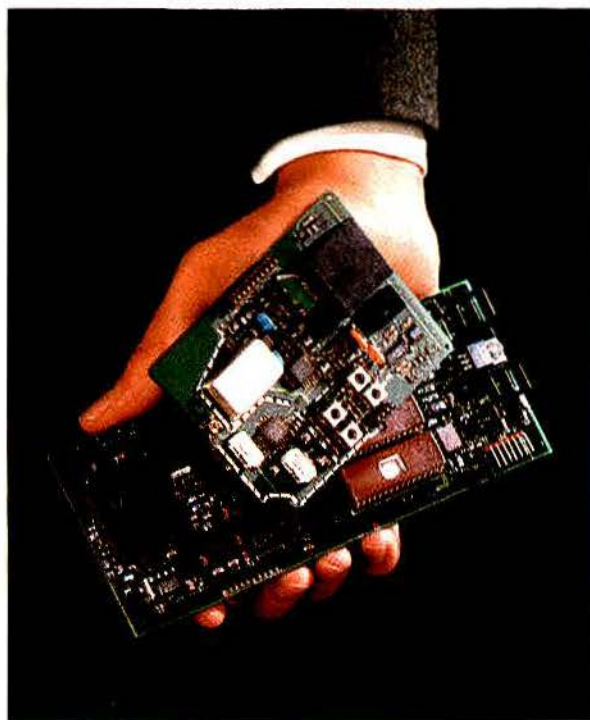
## Introducing the Magellan GPS Receiver Module.

Magellan, a pioneer in GPS technology, introduces the world's first affordable GPS receiver module. Extremely compact and lightweight, the Magellan C/A code module easily accommodates a wide variety of applications.

Magellan's revolutionary gallium arsenide technology and unique PowerSaveR™ design provides for extremely low power consumption, making this module ideal for almost any navigation and position integration requirement.

## GPS—the fastest growing market for navigation/positioning technology.

The Global Positioning System offers extremely accurate, worldwide three-dimensional navigation and positioning on demand. After many recent successes in the GPS



*Magellan's GPS receiver module, a two-board set pinned back-to-back, weighs an incredibly light 7 ounces and consumes only 250 mA.*

satellite launch program, worldwide 24-hour lat/lon coverage will be achieved this year.

To help you move into this fast-growing market, Magellan's boardset offers the ultimate in flexibility. Choose from a variety of electrical interfaces and software modules to meet your specific needs. In addition, a wide

range of engineering support is available. Magellan: putting affordable GPS technology at your fingertips.

**For more information**, call or write: Magellan Systems Corporation, 260 E. Huntington Dr., Monrovia, CA 91016, Phone: (818) 358-2363 Fax: (818) 359-4455.



**MAGELLAN**  
WE BRING GPS DOWN TO EARTH™

Magellan™ and PowerSaveR™ are the trademarks of Magellan Systems Corporation.



# The Source!

**Decibel is the only complete source for low and high power RSA (and suburban) antenna systems.**

As a leader in both antenna systems equipment and RF power amplifiers, Decibel Products is in a unique position to create the low and high power systems needed for RSA and cellular systems. And we have come through for you!

Now, only Decibel offers top quality base antennas, RF power amplifiers, tower top amplifiers, Tx combiners, Rx multicouplers, filters, remote site monitors and HELIAX® cables ... everything you need for a complete RSA (or suburban) antenna system.

#### 806-960 MHz Base Antennas

New DB812F handles 500 watts, DB812HF 1000 watts and DB812HP (pressurized) 1200 watts input power. All are Dual Skirt Dipole™ omnis with 12 dBi gain and 0.5° electrical downtilt. Up to 110 MHz bandwidth. Horizon Blue™ fiberglass radomes that resist winds to 150 mph (241 km/hr).



#### RF Power Amplifiers

Decibel's 45 watt amp was one of the first dynamic models on the market as an AT&T compatible plug-in unit. Thousands have been sold. Now, Decibel offers a similar amp with 55 watts, also 100 and 160 watt amps with built-in cooling fans. A 200 watt RF power amp will be introduced soon.

#### Transmitter Combiners

Decibel's SP8460 series of high power active cellular combiners incorporate 100 or 160 watt RF power amps with the DB9071, which combines 2 to 20 channels as close as 250 MHz. It includes circuit breakers and a low pass filter.



#### HELIAX® Cables

Decibel carries foam, air dielectric and Superflexible cables and accessories.



HELIAX is a registered trademark of Andrew Corporation.



#### Tower Top Amplifiers

Special versions of DB8900 series pre-amplifiers, used at the top of the tower, provide 20 dB gain to overcome line loss, improve Rx sensitivity and extend "talk-back" range.

#### Filter Products

DB4250 series Rx filters give broadband responses for all cellular bands to prevent intermodulation and Rx desensitization.



DB4200 Tx Bandpass Filter, with 20 MHz bandwidth, uses a 6-cavity filter with aperture coupling to handle up to 600 watts of input power.

#### Receiver Multicouplers

DB8500 series modular Rx multicouplers allow 4 to 32 Rx on a single antenna. Now with optional GaAsFET amplifier!

#### Remote Site Monitors

Sentry 8000™ Monitors — with microprocessor, CMOS circuitry and optional DB HOST software — monitor and control remote antenna sites, providing automatic paging, voice reporting and record keeping.



#### For More Information

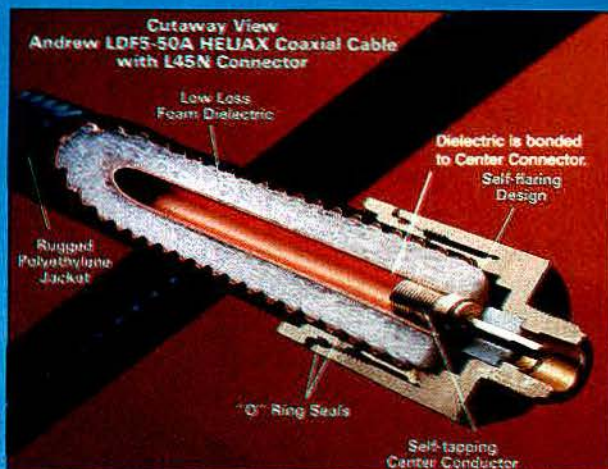
Contact Marketing, Decibel Products, P.O. Box 569610, Dallas Texas 75356-9610. Telephone (214) 631-0310. FAX (214) 631-4706.

An Alliance Telecommunications Company



**Decibel designs systems that communicate ... quality!**





# HELIAX® Coax

**Decibel, a leader in base station antennas, is also a top seller of HELIAX cables, connectors and accessories. Here's why:**

## Customers want lasting quality.

Both Decibel and Andrew have set industry quality standards for half a century. Quality Control employees at each company inspect antennas and cables both during fabrication and prior to shipment.

Decibel antennas must pass tests for intermodulation generators and power handling capability. Andrew cables and connectors are designed to resist moisture and RF leakage.

## Customers want broad selection.

Decibel offers more than a hundred 30-1000 MHz antennas and the antenna systems equipment you need to complete your site, including HELIAX LDF® foam, air dielectric and Superflexible cables and accessories.



## Customers want good service.

Decibel stocks almost all sizes of cables and cuts them to length with connectors fitted at one or both ends, if desired. The antenna end of the cable is wound on the outside of the coil so that it can be hoisted directly up the tower, with trimming done from the transmitter end, if needed.

## Customers want good prices.

Although Decibel and Andrew prices may be a little higher initially, they're actually lower in the long run. Bottom line costs are actually less because your systems perform better and last longer.

Antenna systems with Decibel antennas and Andrew cables, used together, have given outstanding performance for decades in severe and hostile environments.

HELIAX is a registered trademark of Andrew Corporation.

## For more information

Contact Marketing, Decibel Products,  
P.O. Box 569610, Dallas TX 75356-9610.  
Telephone (214) 631-0310.  
FAX (214) 631-4706.

**Decibel antennas pictured (L to R)  
are DB408, DB859, DB559**

Decibel is an Alliance Telecommunications Company.



**Decibel designs systems  
that communicate ... quality!**





## EAR-MIKE™ FOR HANDS- FREE PORTABLE RADIO COMMUNICATIONS

### —even under protective suits or breathing apparatus.

Use the Ear-Mike with a portable radio to ensure uninterrupted two-way communications at critical moments.

As you speak, the vibrations from the voice box (larynx) carry to the inner ear where they are picked up by the Ear-Mike and transmitted via the portable radio. A variety of ingenious push-to-talk switches leave the hands free to do other work. And, these voice transmissions are remarkably clear, even when whispering.

The Ear-Mike is ideally suited for discreet communications in investigative or security work. SWAT teams stay in communication with weapons at the ready. Emergency paramedics and rescue workers transmit while their hands



are busy with other work, and communications by firefighters or Haz-Mat personnel are not hampered by protective suits or breathing apparatus.

Ear-Mike—for hands-free, continuous two way radio communications at the critical moments—may help save the day, may even help save a life. For information write Telex, 9600 Aldrich Avenue South, Minneapolis, MN 55420.

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# TELEX

Circle (47) on Fast Fact Card

## New products

### Digital multimeter measures to 1,000Vdc, 750Vac



Model 2701 3½-digit autoranging digital multimeter operates for 800 hours on a 9V battery. The **B&K Precision** unit's accuracy is 0.5%, and it measures voltage to 1,000Vdc and 750Vac. The DMM measures dc and ac current and resistance and incorporates a diode check and an audible continuity checker. The tester comes with test leads, storage pouch, schematic diagram and parts lists. The unit has two test probes and a belt clip.

Circle (487) on Fast Fact Card

### Tone-and-voice pagers come with 3-year warranty

Shinwa tone-and-voice pagers available from **VCP International** include two-tone sequential, monitor functions, lowband, highband and UHF. The pagers come with a three-year warranty.

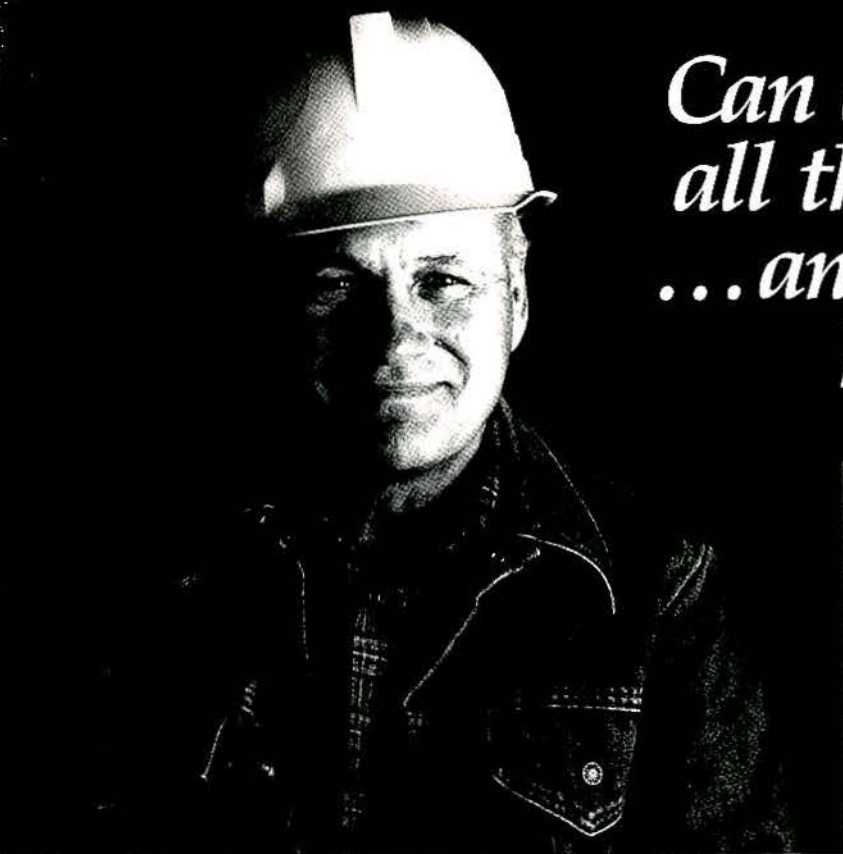
Circle (471) on Fast Fact Card

### Batteries, accessories enhance product offerings

Replacement batteries, eliminators and accessory additions to **Multiplier Industries'** product lines include 15 items in the two-way line and 34 products in the cellular line. Replacement batteries for Motorola Saber and GE MPD, TPX and PLS radios are included for two-way radios. Batteries and eliminators for Motorola's Flip Phone, NEC's P300, Audiovox's CTX5000, Nokia-Mobira's P-30 and Radio Shack's CT300 are included in the cellular line.

Circle (485) on Fast Fact Card





*Can anyone deliver  
all the radio I need  
...and leave off the  
high price tag?*

## Maxon can.

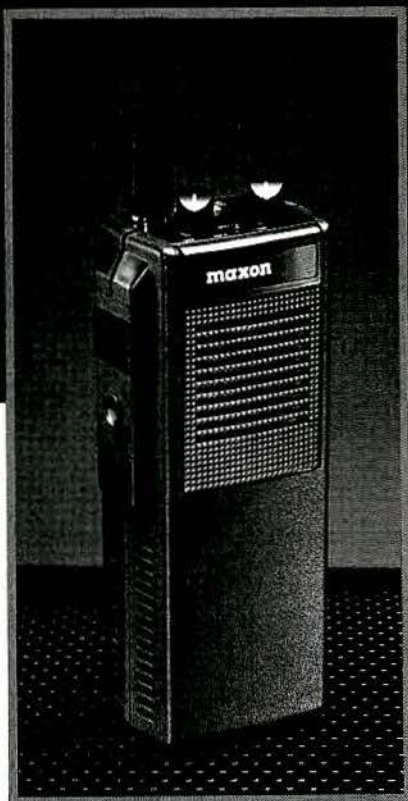
Two channel capability, up to 2 watts RF output and a durable glass epoxy circuit board housed in a compact ABS case — you get all this and Maxon's one year parts and labor warranty for as little as \$179.

In addition, the CP-1000 series portable is equipped with an adjustable squelch,  $\frac{1}{4}$  x 32 stud mount antenna connector, jacks for an earphone and external mic / P-TT / in-unit battery charging, a handy "TX" / "Battery Low" L.E.D. indicator and a large push-to-talk control with a convenient "Monitor" button.

An 8 hour / 500 mAh rechargeable battery, wall-type charger, flexible antenna and a metal belt clip are included with each radio.

Maxon also offers a vox (voice-activated) unit and headset, drop-in charger, external speaker / mic and a leather case as optional accessories.

And the list goes on, but the bottom line is this: Only the new CP-1000 series VHF and UHF two-way FM portable radios deliver these features and this level of performance at anywhere near the price.



## MAXON CP-1000 SERIES TWO CHANNEL PORTABLE RADIOS . . .

**From \$179.00**

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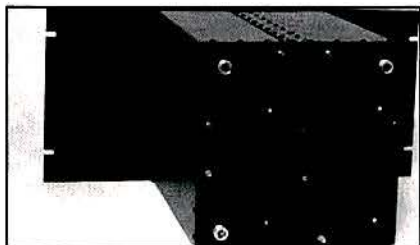
In Canada, contact Omni Provincial Electronic Inc.:  
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## New products

### Modular combiners suit network expansion uses

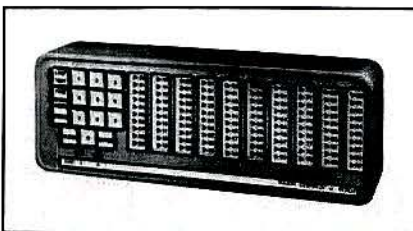


SM890 series combiners include a modular, compact design that supports network expansion. The **Celwave** units come in four-, eight-, 12-, 16- and 20-channel versions. The four- and eight-channel units boast continuous duty output of 70W per channel.

Circle (474) on Fast Fact Card

### Silent dispatch system works in highband or lowband

The silent dispatch system from **Reach Electronics** allows a customer to "page" a route vehicle directly, without going through a dispatcher. The silent dispatch unit in the vehicle turns on a panel light that corresponds with the customer who initiated the call. No sound is produced, and the driver does not need to be in the vehicle when the call is received. The system operates through a radio common carrier using RPC1 (formerly POCSAG; also known



as CCIR No. 1) numeric paging format in either highband or lowband.

Circle (486) on Fast Fact Card

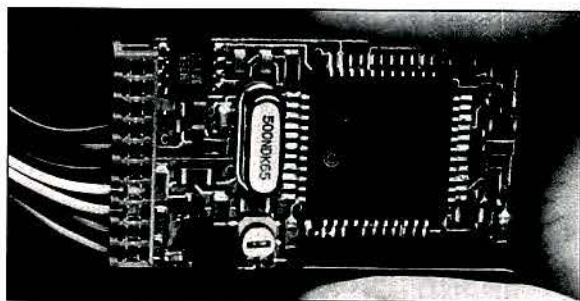
### Mobile data modem provides error-free communications



The IQmodem from **Coded Communications** uses digital signal processing to provide error-free, 4,800bps data communications in two-way radio applications. The queuing data modem includes digital channel sensing, message buffer memory and forward error-correction protocol. The modem works with existing MDI mobile data systems.

Circle (467) on Fast Fact Card

# Finally... The Premium Tone Board



C1116 - CTCSS Encoder/Decoder

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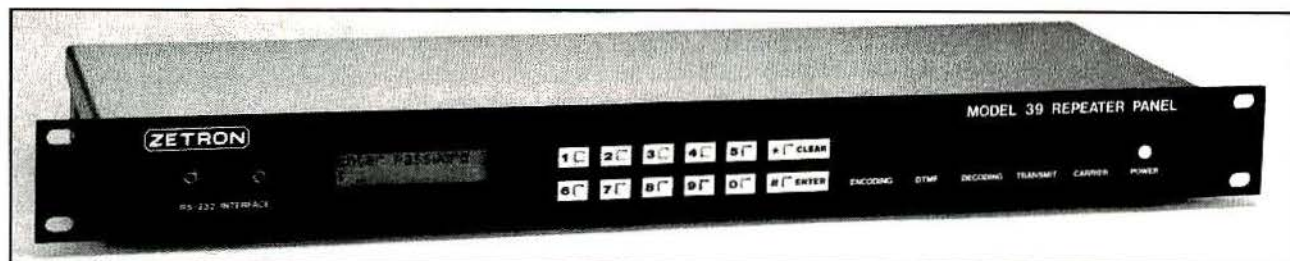
**SIGTONE**

- **50 field programmable CTCSS tones** — provides full compatibility with new "State-of-the-Art" repeater panels
- **"Square" frequency response** — allows use of very close spaced adjacent CTCSS tones without falsing
- **Digital Analysis Decoder** — provides ultra high decode sensitivity with superior "Talk off" performance
- **Multiple Tone capability** — allows separate channels to have different CTCSS tones
- **Reverse Tone Burst** — eliminates annoying receiver "squelch" tail
- **Variable Time Out Timer with audible alert** — prevents stuck mic's from locking up the channel
- **TX lockout** — gives operator a "busy" signal if the channel is busy. Just like in trunking
- **Built-in high pass filter** — removes CTCSS modulation from the audio path
- **Universal interface** — provides extremely flexible interface, allows installation in virtually any radio
- **Ultra small size** — 1.6" x 0.9" x 0.25"

Circle (49) on Fast Fact Card



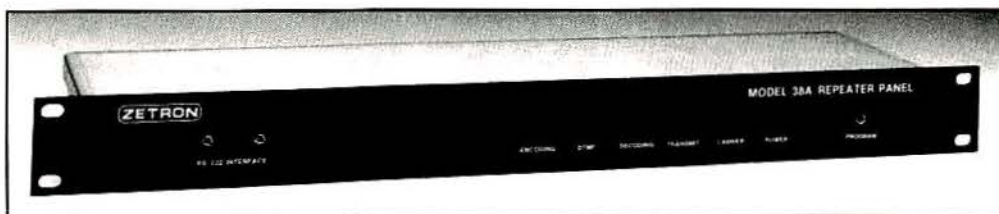
# TOP OF THE LINE



The Premium Repeater Panel That Gives You All The Features You've Asked For

- Keypad and Display for Local Programming
- Full Remote Programming and Control, Even While In Operation
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- Ultra High Performance ToneLock Tone Decoding
- Internal Dual Time Constant Squelch
- 60 Milliamp Low Current Operation
- Real Time RS-232 Control
- Airtime Billing Software Package Available

## ECONO LINE



The Repeater Panel That Gives You Top Performance At A Budget Price

- Full Remote Programming and Control, Even While In Operation
- 38 CTCSS Tone and 22 Digital Squelch Code Capacity Standard
- 50 CTCSS Tone and 18 Digital Squelch Code Capacity Optional
- Ultra High Performance ToneLock Tone Decoding
- Real Time RS-232 Control
- Airtime Billing Software Package Available

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## New products

### Interface allows hearing impaired to send pages

A telecommunications device for the deaf (TTD) interface for **TekNow's AlphaBox** enables hearing impaired users to send alpha messages from their TDD input devices to any alphanumeric pager. The AlphaBox and TTD are compatible with current paging terminals. Other additions are the Faxbox and Future Paging. Faxbox sends a detailed re-

Circle (482) on Fast Fact Card

port of the day's pages, date, time, subject and content to each customer on a daily basis. Future Paging allows a user to send "reminder" pages at a specific time and date and provides for automatic repeat paging. Another enhanced version of the AlphaBox, the PageRouter, allows the system to act as a regional paging gateway.

### Numeric pager features built-in alarm clock

The Axess-N numeric pager from **Ericsson Paging Systems** features a built-in alarm clock and a flip-down "read-from-the-hip" holster. The pager offers internal memory backup, storage of as many as 12 numeric messages of 20 characters each, automatic time stamping, backward and forward message scrolling and low-battery indicator.

Circle (491) on Fast Fact Card

### Financial market data can reach paging subscribers

The Quote Alert System from **Quotes Plus** enables a paging company to provide its subscribers with real-time stock market information. The service operates via a desktop computer that directly links the financial markets with any paging terminal through a standard RS-232 serial interface. Quotes can be sent every trading day at preset times.

Circle (222) on Fast Fact Card

### Lowband mobile boasts 45 channels, 60W RF output



Model RML60 45-channel, 60W high-power lowband portable from **Relm Communications** includes track tuning, instant priority and area scan. It covers the 30MHz-to-50MHz band in two versions: The RML60A spans 30MHz-to-43MHz, and the RML60B includes the 37MHz-to-50MHz band. Built-in features include time-out timer, busy-channel lockout, whine filter, cloning and IBM PC compatible programming.

Circle (480) on Fast Fact Card

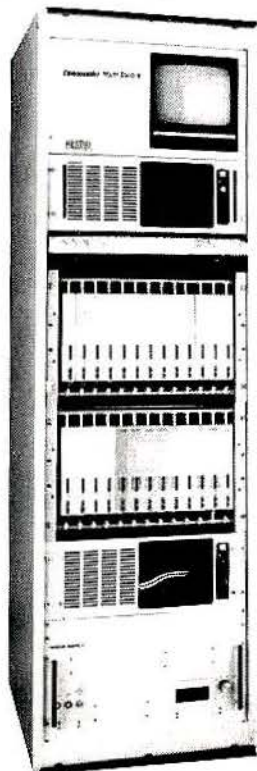
## ENHANCED SERVICES FOR ENHANCED PROFITS

The Commander MultiSwitch is more than just your classical mobile/paging switch. You can now be the "one-stop" communications provider necessary in today's communication marketplace.

### STANDARD ENHANCED SERVICES

- Talk back paging on any channel
- Call forwarding to office, home, or vehicle
- Group calls (tag any type pager together)
- Telephone resale
- Selectively assigned call durations.
- Mobile roaming services
- Page transfer to Telephone Number Retrieval (TNR)
- Time stamp pages for later recall via subscriber trunk
- Telephone trunk concentration
- Least cost call routing

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Chicago Ridge, IL 60415  
(708) 424-6464 Fax: (708) 424-6492**



Circle (51) on Fast Fact Card



# ANNOUNCING THE FIRST PIGGY TO BREAK THE SOUND BARRIER.

## Portable Phone Performance Soars To New Heights.

Now there's a fast way to get higher performance from a cellular portable phone.

The new Larsen® KGB-825 installs in seconds, improves signal strength, increases phone versatility, and reduces dropped calls – propelling you to higher portable phone sales.

The KGB-825 works without a coaxial cable hookup (the first cellular mobile antenna to make that claim). There are no tedious connections to make or break each time the portable phone is moved out of the vehicle. It also restores lost signal strength, making a portable phone as effective inside a vehicle as out.

## It's One Powerful Little Piggy.

The KGB-825 works as a passive repeater antenna, passing signals to and from the externally mounted gain antenna element. Larsen's patented\* impedance-matching circuitry creates a low impedance power transfer through the glass, producing peak performance for the portable phone. No tuning is required.

## Now Available In Clip-on Mounting For Easy-On, Easy-Off Use.

Installation is a breeze with our new KGBK-825 Kùlklip™. Just clip on the antenna and roll up your window.

For detailed, independent test results call us toll free for more information.

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IN U.S.A.: call toll free 1-800-426-1656 or 206-944-7551.  
IN CANADA: call toll free 1-800-663-6734 or 604-872-8517. Larsen® is a registered trademark of Larsen Electronics, Inc. \*Kùlklip™ antenna series U.S. patent #4,764,773.

Circle (52) on Fast Fact Card





## New products

### Trunked, cellular testers provide precision readings

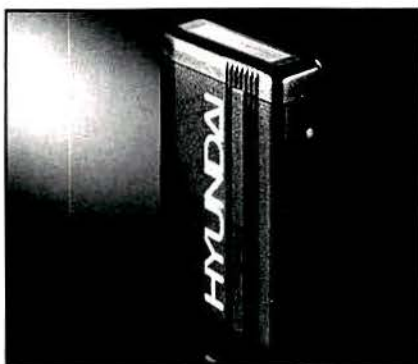


The CMT 82, CMT 84 and CMTA 84 from Rohde & Schwarz incorporate built-in signaling units for testing trunked and cellular radios. The units offer precision measurement of AM, FM and SSB.

Circle (247) on Fast Fact Card

### Numeric pager possesses vibrating option

The Impact pager made by Hyundai and distributed exclusively by International Telecom is a numeric display unit that incorporates a vibrating option. The pager features a 12-digit LCD, four addresses, two cap codes, a low-battery alarm, duplicating message detection, alert tone with silent mode and four memories capable of 20-digit storage each.



Circle (213) on Fast Fact Card

### Trunked radio remote controls Johnson unit



Model 94 trunked radio remote controls E. F. Johnson 8600 series trunked radio. As many as 10 desktop remotes can control a single Johnson unit. The Zetron remote includes scan, lockout, monitor, transmit, LED display and up and down controls for system and group. The remote also features an intercom switch, privacy control and a supervisor function. Systems that include more than one remote require a Zetron model 96 extended local interface connected to the Johnson radio. Remotes can be placed as far as 2,000 feet from the interface unit.

Circle (506) on Fast Fact Card

## Interceptor 5103™

### Digital Paging System Analyzer

"Off the Air System Analysis"

**Turbo Charge your Digital Paging System!**

**Maximize pager capacity per channel!**

**Minimize busy hour delays!**

- \* Golay, NEC and Pocsag 512 / 1200.
- \* Real time display of all modes.
- \* Capcode, function code, pager type, synch code or preamble and data message.
- \* Batch fill and efficiency analysis.
- \* Break down of data stream to binary level.
- \* 24 statistical summary - pages, data words and addresses per second.
- \* Pager trap and logging.

## Page Sitter™

### Page Monitoring and Retrieval System

**No More Missed Pages**

- \* Tracks over 32,000 Digital Pagers (expandable).
- \* Stores to individual password protected files.
- \* Records Time /Date, Capcode, Function Code, Pager Type and Data Message.
- \* Automatic Decoding of NEC, Golay, Pocsag 512/1200 Synch Codes 1 - 4.
- \* Works with all terminals.
- \* No hardware connections.
- \* Instant retrieval local or remote.
- \* Multiple channels.

## Pop - Page™

### A Pop Up Alpha Paging Program for Your PC

**Full featured at a fraction of the cost.**

- ✓ Unlimited Subscribers & Groups.
- ✓ Uses only 10K of Memory.
- ✓ Multi-tasking operation.
- ✓ Full IXO protocol.
- ✓ Wrap around page logging with recall.

**Only \$19.95**

**Quantity Discounts Available.**

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# AMERICA'S MOST WANTED



## The Slimline Phone Mount Gang

The gang members of this notorious group are being captured by installers across the country. PanaVise Slimline mounts have been sought after due to their sleek design, versatility in use, and ease of installation. Be on the lookout for three varieties of this most wanted mount—the 726, 727 and 728 (all pictured above). They are armed with reliability and considered dangerous to other mounts on the market.

## Universal Radio Mount

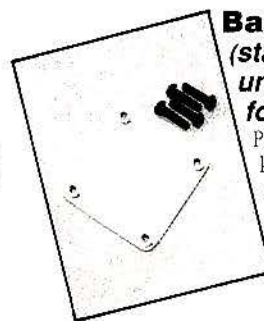
The PanaVise Universal Radio mounts are being put to hard labor due to their rugged toughness and dependability. There are two brands, the 950 (pictured above) and 951, still at large with a gang of posts just waiting to hold up your radio.

Do yourself a favor and sleep soundly tonight — put a PanaVise away for life and never worry about the crimes of a bad installation again.

## REWARD:

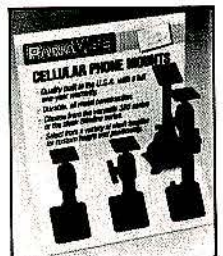
A Quality Installation & Customer Satisfaction

## ACCOMPLICES



### Back-Up Plates (standard foot and under dash small foot)

PanaVise Back-Ups are known for eliminating self-tapping screws and wanted as the perfect hold-up accomplice for dash or console installs.

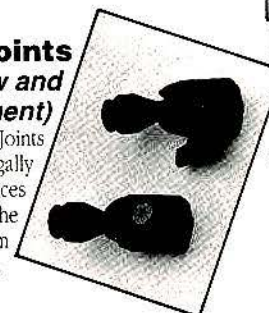


### Phone Mount Display

PanaVise Displays are under suspicion for creating more purchases and highlighting the product line.

### Universal Joints (set screw and knob adjustment)

PanaVise Universal Joints are infamous for illegally entering into tight spaces and stealing the headaches away from tough installations.



# PANAVISE®

1485 Southern Way  
Sparks, Nevada 89431  
Tel: (702) 353-2900  
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## New products

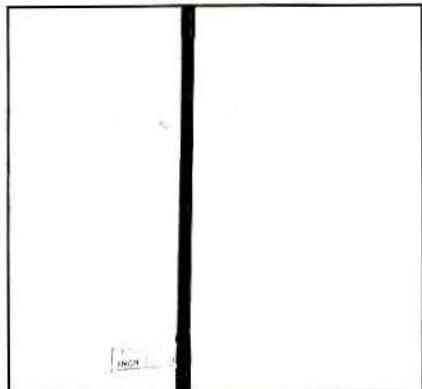
### Mobile data terminal offers formulated forms



The MDT 100 mobile data terminal sends and receives messages from mobile or fixed locations and is based on a forms-handling concept. Forms can be predefined and stored in the Ericsson unit's internal memory. The MDT is designed for use on the Mobitex mobile data network. The MDT includes an operator's unit that controls the terminal and the radio; and a system unit. The system unit has two connections for optional equipment such as an alphanumeric keyboard, a printer, a bar code scanner and a magnetic code scanner.

Circle (509) on Fast Fact Card

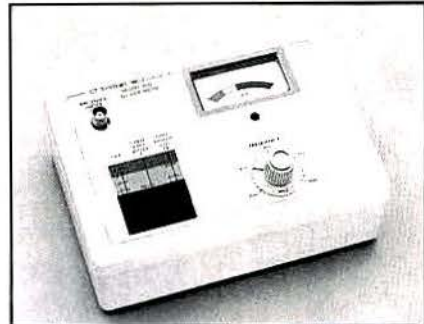
### Static discharger lowers antenna noise



The Precipitation/Corona AS-1 fiber-glass rod provides a discharge path for electrons on towers and antennas to reduce corona noise and precipitation static. The Static Busters static discharger improves noise levels as much as 20dB to 30dB or more, depending on the frequency. It increases range during otherwise noisy periods.

Circle (504) on Fast Fact Card

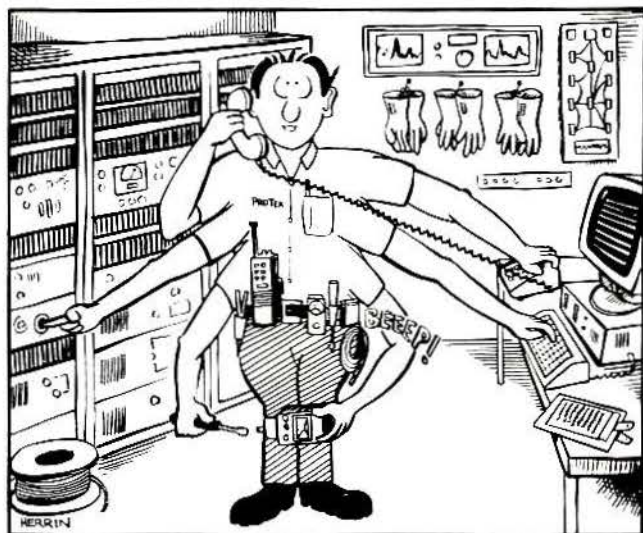
### Trunking, cellular meter has built-in signal source



Model 400 cellular and trunking SWR meter and relative strength indicator includes an SWR meter and built-in signal source. The unit's signal source covers the trunking and cellular 800MHz range. The CT Systems/Wavetek tester verifies antenna performance from 800MHz to 1,000MHz. Connected to an antenna, the meter indicates relative strength across the same spectrum.

Circle (511) on Fast Fact Card

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Astron Corporation is the leading manufacturer of high-quality power supplies and converters for the land mobile industry.

With the new SL-11 series of low profile power supplies, specifically designed for base station applications, the setup is simple, easy and looks attractive. Just mount the radio, with the mounting pads (supplied with the power supply), to the top of the SL-11A (2 $\frac{3}{4}$ " H x 7 $\frac{5}{8}$ " W x 9 $\frac{3}{4}$ " D) or the SL-11R (2 $\frac{3}{4}$ " H x 7" W x 9 $\frac{3}{4}$ " D). The power supplies are very well regulated and will provide 11 amps of current at a 50% duty cycle. The units have fold-back current limiting to protect them from overload and short circuit, and an overvoltage protection feature to protect the radio should the output voltage exceed a safe level. All SL series units are available in dark gray or black.

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SL-11R [black]

SL-11R [dark gray]

**ASTRON** SL-11A



## New products

### Trunked radio system incorporates fiber optics

The OTR-90 fiber optical trunked radio system includes fiber optic, laser and RF amplifier technology to permit full-duplex trunking service in areas where coverage is lacking. Airports, convention centers, large buildings and tunnels are some of the areas suited for the OTR-90. The **Decibel Products** sys-

tem receives signals from the transmitter combiner and converts the signals to 1,300nm amplitude modulated light and transmits it over a single-mode fiber optic cable. A receiver-amplifier converts the light back to RF signals and amplifies them for transmitting by an antenna.

Circle (488) on Fast Fact Card

### Telephone interconnect offers half, full duplex

The TIC-Base full- or half-duplex telephone interconnect from **Northern Controls & Communications** includes DTMF and CTCSS selective signaling and decode; tone or pulse regenerated dialing; programmable CW ID; and over-the-air latching relay operation. The base unit has an external alarm site input. When used with the TIC-ID user interface, the TIC-Base incorporates a full-duplex link for as many as three independent users with standard telephone equipment at the remote locations.

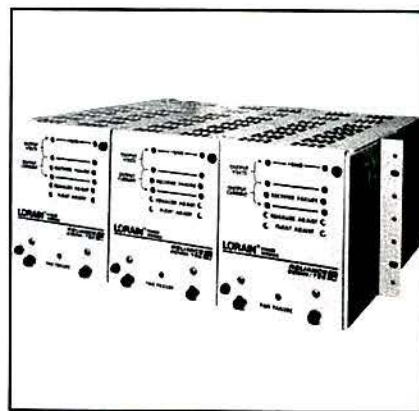
Circle (212) on Fast Fact Card

### GPS receivers suit military, commercial uses

The MX 7100 series rugged, low-power GPS receivers suit cargo tracking, forestry and weapons delivery systems, among other commercial and military uses. The **Magnavox** six-channel units offer uninterrupted continuous tracking of as many as six satellites. The units support high acceleration rates without signal loss.

Circle (496) on Fast Fact Card

### Modular rectifier cabinet holds six 10A circuit cards



Model MZ60CAB 60A modular rectifier cabinet from **Lorain Products** can be configured with six 10A rectifier circuit cards to supply 30A power from a 120Vac input or 60A from a 240Vac input. The unit features overvoltage shutdown, 50A redundancy and a series output diode.

Circle (499) on Fast Fact Card

# Tired of the Same Old Line? Think Links!



The new DCL 1200 radio/modem transceiver by Neulink eliminates the need for expensive leased lines.

Neulink's DCL 1200 transmits your data at a phenomenal 1200, 2400, 4800, and coming soon 9600 bits per second in full duplex or half duplex configurations using VHF, UHF, and 900 Mhz FM radio channels to transfer data between computer systems.

Plus, the DCL 1200 provides interface for any RS-232-C (V.24) data application.

- Each unit is 100% hand tested
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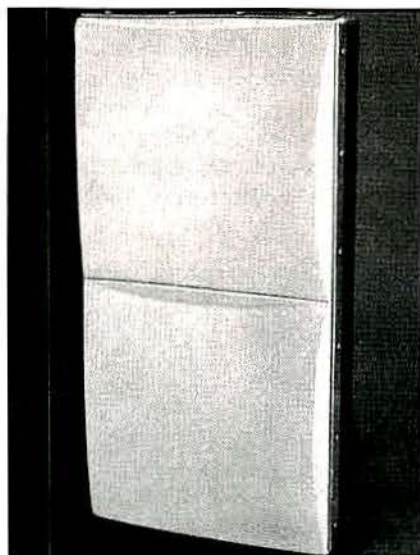
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Circle (57) on Fast Fact Card



### 6dB gain sector antenna places null on horizon

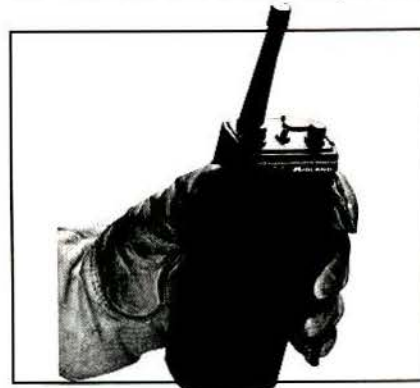


The PD10085L "localizer" 60° panel antenna offers 6dB gain and 25° downtilt with a 30dB null on the horizontal plane. The Celwave unit boasts a high front-to-back ratio and is housed in a weather-resistant radome. The antenna suits 824MHz-to-894MHz range.

Circle (475) on Fast Fact Card

### 2W portables facilitate programming 2 frequencies

VHF and UHF synthesized portables feature programmability for two frequencies. The Midland LMR 2W portables offer preset automatic noise squelch, programmable time-out timer and power saver. Model 70-135 spans the 136MHz-to-174MHz range, and



model 70-235 operates in the 406MHz-to-512MHz range. The portables meet or exceed military standard 810C and D.

Circle (458) on Fast Fact Card

### Database software provides microwave path calculations

The Microwave Database Manager from SoftWright provides microwave path budgeting and site design on IBM PC-compatible computers. It analyzes fade margin, reliability and outage calculations for non-diversity and space-diversity microwave systems.

Circle (500) on Fast Fact Card

### Hand-held DTMF tester handles all 16 tone pairs

Model DTMF-5000 pocket-sized tester from Conway Engineering encodes and decodes all 16 DTMF tone pairs. The unit has an eight-digit display and comes with a rechargeable battery, battery charger, carrying case, patch cords and earphone.

Circle (473) on Fast Fact Card

# Your mobile phone reception is as good as your antenna.

It's no overstatement. The antenna is the single most important factor for good mobile phone reception. That calls for an outstanding antenna: Mobile Mark.

It's the one antenna that goes through an automatic car wash unscathed, without removal. It's the one that never needs retuning. The one that resists signal loss from snow, ice or dirt build-up. The one whose sleek design eliminates wind whistling noise. And the one that stays vertical—like a good antenna should—for maximum gain.

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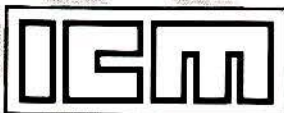
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## New products

**900MHz portable offers  
digital channel selection**

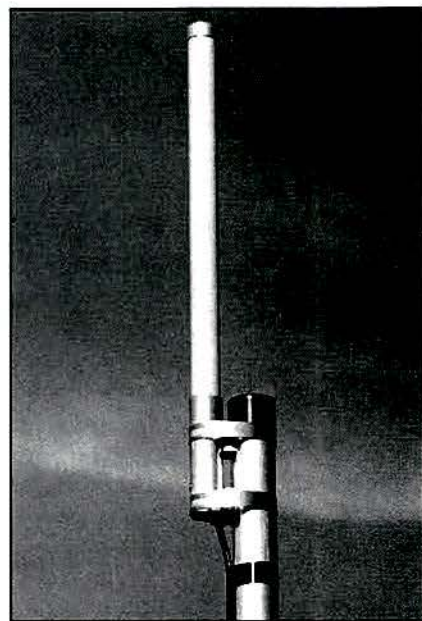


The GE-NET MTL portable radio from **Ericsson GE Mobile Communications** fits the 900MHz spectrum and offers rapid and automatic digital channel selection, privacy, priority group scan and multimode system coverage. The programmable unit is housed in a rugged metal case and meets military standard 810C and D. The portable has a 1,200mAh battery and top-mounted, 16-position selector knob.

Circle (494) on Fast Fact Card

**Omni antennas boast  
fiberglass enclosures**

Fiberglass enclosed omni antennas from **Cushcraft/Signals** are available in 800MHz and 900MHz models. The antennas include plated copper laminated radiators, pigtail-mounted connectors and broad gain bandwidth. Model SB8060B covers 806MHz to 866MHz. Model SB8960B covers 896MHz to 940MHz.



Circle (456) on Fast Fact Card

**Packet radio modem boasts portability**

Radio packet modem 840C-II is a self-contained, portable unit designed to operate on ARDIS, Canada's Mobidata or a private radio system that uses the MDC 4800 radio channel protocol. The

wireless modem from **Mobile Data International** uses a radio channel to communicate instead of wires. Field workers can communicate directly with base operations via the modem.

Circle (493) on Fast Fact Card

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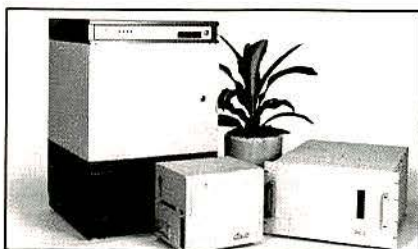
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Circle (60) on Fast Fact Card



## Voice mail systems offer 2 to 24 ports

Cindi "plus" voice mail systems from **Genesis Electronics** offer from two to 24 ports and two to 80 hours of voice storage, plus integration to more than 100 makes and models of telephone systems. The enhanced Cindi I+ and Cindi II+ offer a personal user menu that provides each mailbox owner with a single-level automated attendant for custom call direction options, such as transferring a call or leaving a voice message. The units also have a "zero to transfer"



function that enables a user to press "0" to transfer to any extension.

Circle (481) on Fast Fact Card

## Coverage extender includes fiber optic, RF techniques

The Micro Lite coverage extender system made by **Decibel Products** incorporates fiber optic, RF, laser and amplifier technology in its operation. The system extends coverage for microcell, personal communications network and cell extender applications. The system receives signals via an interface panel

from existing or new cell sites, and an optical transmitter converts the RF signals to 1,300nm light for transmitting over a single-mode optical fiber. A power amplifier converts the light back to RF and amplifies it for transmitting by the antenna.

Circle (457) on Fast Fact Card

## Software produces fault-tolerant CAD

The AlertCAD dispatch software provides reliable and fast dispatching, increased throughput, improved CPU clocking and reduced operating system overhead. The **Scientific Software** dispatch system includes no wait coding; event-driven coding; forward and backward scrolling; interchangeable dual work areas; color warning screens; short-cut commands; and separate message queues. The fault-tolerant system runs on Stratus or IBM fault-tolerant hardware.

Circle (507) on Fast Fact Card

## Portable analyzer permits storage of test setups

Model R-2600A portable communications analyzer includes duplex and sweep generators; a spectrum analyzer; a sensitive receiver; RS-232 remote control; color monitor port; self-calibration; and on-board signaling. The **Motorola** tester offers digitized screen bit mapping, window and softkey functions, fast-reacting autoranging scales with analog and digital readouts, permanent storage of frequently used test setups, and signaling encode and decode functions.

Circle (218) on Fast Fact Card

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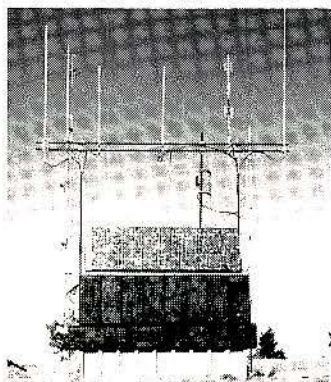
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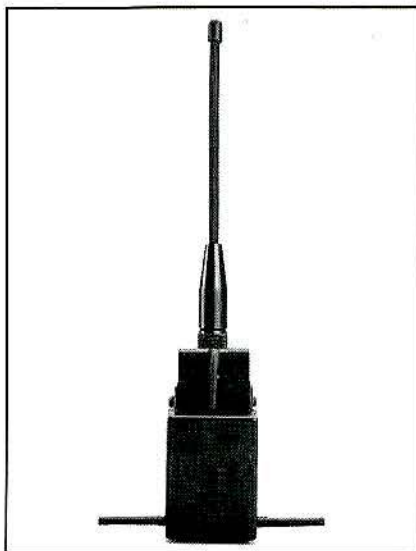
## New products

### Cellular phone charger fits Motorola PT-500

The TCP-500 mobile rapid charger from **Telecom Cellular Products** fits Motorola's PT-500 cellular telephone and increases talk-time power 24 hours a day. The unit requires a two-wire hookup to any vehicle power source.

Circle (498) on Fast Fact Card

### Cellular antenna installs over side glass window



The Passive Repeater window-clip cellular antenna includes an inner receiver box with dual 1/8-wave tuned receiver radials. The **SureCall** antenna installs by an over-the-glass mounting on any opening side window of a vehicle. Three versions of the mini portable antenna are available.

Circle (490) on Fast Fact Card

### Fax service notifies subscribers of transmission

The **Cue FaxForward** service permits fax transmission to a system subscriber without knowledge of the subscriber's location. The sender merely routes the fax message to the paging subscriber's personal 800 number. The fax arrives at Cue's Message Center, which signals the subscriber's pager of a fax transmission. The subscriber retrieves the fax from any facsimile machine by dialing a separate 800 number.

Circle (217) on Fast Fact Card

### Synthesized mobile sports built-in data interface

The MTD 16 Plus mobile radio incorporates an eight-digit alphanumeric display, capacity for 10 preprogrammed special calls, telephone interconnect and a built-in 9,600 baud interface for data applications. Capabilities include multisite operation, PTT ID, remote radio disable and dynamic regrouping. The **Ericsson GE Mobile Communications** unit meets military standard 810C and D specifications.



Circle (431) on Fast Fact Card

## -tone & voice



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- Low band, VHF, UHF
- Two tone sequential
- Single "AA" battery
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- Locking battery compartment
- Group call command

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Circle (65) on Fast Fact Card



## Desktop dispatch console expands to 16 channels

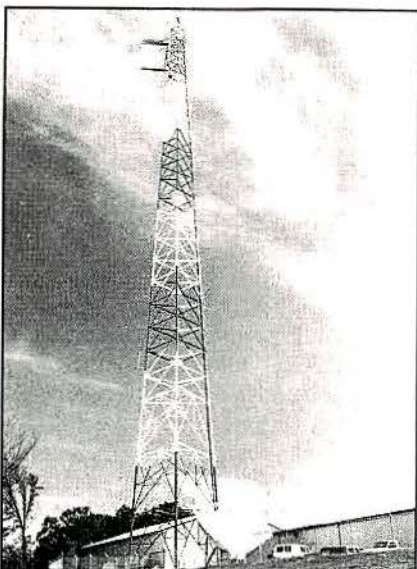


The Ultra-Com 96 desktop dispatch console from **Modular Communication Systems** expands to a 16-channel capacity with the use of channel cards. Features include a management information package, personal vehicle status information, user programmability and a G-Star interface. The system is available in an integrated switch and super twist LCD version and a CRT version. The versions offer on-board multiformatted paging.

Circle (472) on Fast Fact Card

## Self-supporting towers have galvanized components

Tubular steel or solid leg members and hot dip galvanized components make up **Rohn's** self-supporting towers.



The three-leg triangular design is strong and improves load capacities. Custom designs are available for towers as tall as 500 feet. Model SSV can be combined with model SSMV, which is designed for increased capacity and wind load.

Circle (470) on Fast Fact Card

## Voice processing system supplies messaging, dispatch

The PC-based Hello enhanced voice processing system suits radio paging, cellular and other communications uses. The **Enhanced Systems** system includes voice messaging, audiotex bulletin boards, outbound call processing, al-

phanumeric dispatch and voice recognition. The Hello software is modular and interfaces to any radio paging or cellular system and to all standard trunks and data interfaces.

Circle (483) on Fast Fact Card

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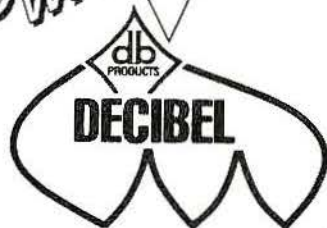
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With its 3-inch Horizon Blue™ fiberglass radome, Decibel's Dual Skirt Dipole™ antenna resists winds to 150 mph, with one-half inch of icing.

### Specifications

**Range:** 806-960 MHz  
**Bandwidth:** up to 110 MHz  
**Gain:** 12 dBd  
**Downtilt:** .5 built in  
**VSWR:** 1.5 to 1 or better  
**Power:** 500 watts max.  
**Impedance:** 50 ohms  
**Length:** 206" or 200"  
**Flange:** Fixed

Other features include dipole collinear arrays, a 28-inch aluminum alloy extension pipe for mounting, a grounding brass tube from top to bottom for lightning protection, and drain plugs for moisture evacuation.

All radiators, feed and matching system components are made of copper or brass, which reduces intermodulation when several transmitters are combined on the same antenna.

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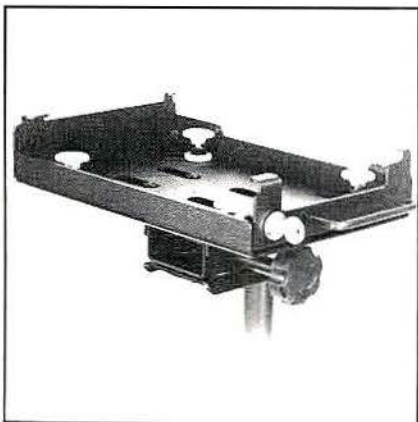
Circle (67) on Fast Fact Card



## New products

### Mounting head incorporates sliding drawer maneuver

A mount head for **Gamber-Johnson's** Grid 1500 series laptop computers, the DS-15, fits any of the company's DS modular mount bases. It includes a sliding drawer movement with a handle for quick installation and removal. A key lock on the drawer is standard.



Circle (484) on Fast Fact Card

### Repeater series contains built-in duplexer, power supply

The Repeater Plus series of repeaters includes wall-mount and desk-mount versions. The **Ritron** desktop version operates as a repeater and base station and includes a built-in speaker; volume and squelch controls; and provision for as many as four CTCSS or two DCS

encoder-decoder modules. The wall-mount version includes built-in switch-programmable CTCSS encoder-decoder and local test speaker jack. Both versions have a built-in duplexer and power supply.

Circle (215) on Fast Fact Card

### 2,000-channel scanner probes 36 channels per second

The **Ace Communications** 2,000-channel receiver covers 1MHz to 1,500MHz and scans 36 channels per second. The scanner boasts high speed, broad coverage and a built-in interface to an RS-232 port. The unit is for tabletop or under-the-dash use. The receiver can scan 62 banks of 32 frequencies for 1,984 scanned frequencies, and 16 memory locations are set aside for beginning and ending search limit frequency pairs. The unit slows scan rate to compensate for tuning lags when adjacent frequencies are more than



30MHz apart.

Circle (468) on Fast Fact Card

## Cellular Antennas

Mark manufactures 8, 9 and 10 dB Cellular Directional and Omni Directional Antennas.

Our highly directive Cell Enhancement Antennas are available in parabolic grid, solid and high performance models for the non-wireline and wireline frequency bands of 825-885 MHz, 835-895 MHz, and wide bands in the 825-895 MHz range.

These antennas can be used for better coverage at the remote site or to improve coverage of mobile units.

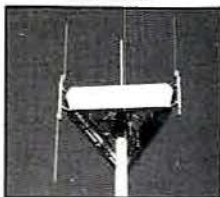


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Circle (69) on Fast Fact Card



## Wideband, lowband mobiles deliver 2W to 50W RF

Model 70-0351 dash-mount and model 70-0355 remote-mount mobile transceivers operate from 29.7MHz to 36MHz, 36MHz to 42MHz or 42MHz to 50MHz without retuning. The **Midland LMR** mobiles program for 22 channels, a capacity that expands to 99 channels with a plug-in module. Output power adjusts from 2W to 50W. Features include a built-in dual-priority channel scan that covers 40 channels per second; a built-in noise blanker with internal enable-disable switch; and die-cast chassis. The synthesized units meet



military standard 810C and D. An external jack permits programming via a PC, data module EEPROM programmer or cloning.

Circle (466) on Fast Fact Card

## Radio cases sport quick-release swivels



Circle (465) on Fast Fact Card

Protective cases for two-way radios from **A.W. Enterprises** feature stamped metal quick-release swivels for disconnecting units. The swivel is 1/4-inch thick and is 2 ounces lighter than the die-cast swivel it replaces. The stamped swivel is compatible with the company's previous teardrop swivels. It is available on the complete line of two-way radio cases.

## Battery conditioning system fulfills NiCd charging needs

The **Discovery** battery conditioning system recharges and conditions two-way and cellular NiCd batteries. The unit restores 100% of a battery's rated energy automatically and protects a battery from overcharging. The system is made by **Surecharge Industries**, and conversion kits are available for Motor-

ola, Ericsson-GE, ICOM, Maxon, RCA, Ranger, E. F. Johnson, Bendix/King and Standard Communications two-way radios. For cellular telephones, conversion kits are made for Motorola, NEC, Mitsubishi, GE, Panasonic, Nokia-Mobira, NovAtel, Audiovox and Radio Shack.

Circle (469) on Fast Fact Card

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- ★ Stuck Microphones
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- ★ ELT Search & Rescue



New Technology (patented) converts any VHF or UHF FM receiver into a sensitive Doppler shift radio direction finder. Simply plug into receiver's antenna and external speaker jacks. Models available with computer interface, synthesized speech, fixed site or mobile - 108 MHz to 1 GHz. Call or write for details.



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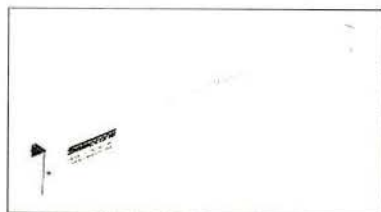
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Circle (70) on Fast Fact Card

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what it takes!*

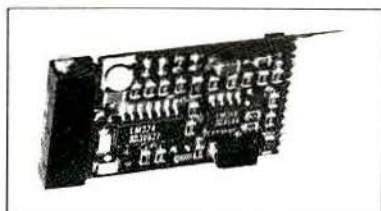
**Selectone**

Tone Signalling · Remote Controls



**Shared Repeater Panel  
ST-180**

The Selectone Model ST-180 Shared Repeater Panel performs all audio processing, timing and control functions required to allow multiple users on a shared radio repeater. Designed for smaller repeater systems with up to eight users, the low cost ST-180 provides many of the same features found in more expensive panels. Features such as **digital CTCSS programming, busy channel lockout, tone translation and remote on/off control [optional]**.



**Miniature Universal CTCSS  
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Model ST-146**

The industry's smallest CTCSS encoder/decoder, measuring only 1.68" L x .81" W x 0.25" H for easy mounting in almost any mobile or portable radio. Includes high-pass filter and multiple outputs for easy interface to almost any radio squelch circuit. Field Tunable from 67.0 to 250.3 Hz. Operates on 5.5-16Vdc at less than 5 mA. Decode sensitivity is 10 mV when supply below 8 Vdc. Frequency stability better than 0.2%. Mounts with double sided tape. Call Hutton to order.

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Circle (71) on Fast Fact Card



## New products

### VHF, UHF mobiles feature 4-, 12-channel versions



Model FTL-2011 Vertex VHF mobiles include 40W RF output and 26MHz frequency spread; UHF models FTL-7011 offer 25W at 36MHz spread. Both Yaesu models are available in four-

and 12-channel versions. The 12-channel versions can be upgraded to 24 channels. The models are IBM PC field-programmable with cloning capability and meet military standard 810C and D. The mobiles offer built-in CTCSS, user-programmable accessory button for high- low-power output, talk-around and call alert, time-out timer, busy-channel lockout, 5W audio power output and heavy-duty mic.

Circle (479) on Fast Fact Card

### Modem links MDT to Mobitex network

Operating at a speed of 8,000 bits per second, the C719 modem links a mobile data terminal to the Mobitex mobile data network. The Ericsson modem suits uses such as field personnel, public safety, transportation and utility companies.

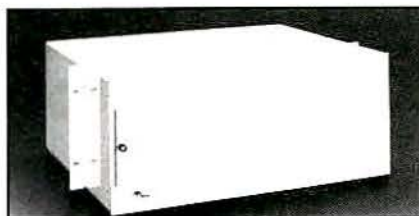
Circle (512) on Fast Fact Card

### Portable cellular antenna mounts to vehicle window

With the use of a TNC connector, the portable cellular telephone vehicle window antenna mount assembly from Kuby Communications mounts easily without the use of tools. The cellular mount slips over the edge of a vehicle's glass. It includes 10 feet of coaxial cable.

Circle (245) on Fast Fact Card

### PC or DTMF signaling controls voice switch



Model 376 voice frequency switch includes 16-line capacity, which is expandable to 32 lines. Mobile radio, base station and telephone circuits may be interconnected via a standard PC-type computer controlled by a software program from Raven Electronics. A color display shows the status of switch connections on a port-by-port basis. Standard features may be selected and programmed in the field. They include port destination, security passwords, monitoring, conference and supervisory override.



Circle (478) on Fast Fact Card

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The "Smart Vox", used with any of our audio accessories, will recognize your voice in varying noise - from quiet to deafening - and will consistently turn on your radio . . . but only when you talk. No loss of words at the start of a message, no false keying, no adjustments, no modifications.

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Circle (72) on Fast Fact Card



## Booklet describes optics control research

"Current Research and Studies On Optics Control" by Anritsu includes technical detail and diagrams on five optics control techniques. The 38-page booklet describes high-speed modulation of lightwaves; control of optical waves via non-linear optical effects; development of a hyper-coherent optical sweep generator using semiconductor lasers; phase-conjugate optics using dye-doped films; and semiconductor quantum effect devices.

Circle (206) on Fast Fact Card

## Brochure describes computer batteries

Cells and custom packs for computer batteries are included in PowerPak's reference guide. The brochure contains Panasonic and Electrochem lithium computer battery specifications and a cross-reference section.

Circle (204) on Fast Fact Card

## Pricebook covers mobile communications

Base stations, mobile antennas, cable, connectors, batteries, power supplies and remotes are included in Cartwright's pricebook.

Circle (209) on Fast Fact Card

## Industry calendar lists shows, meetings, conferences

The 1990/91 Electronics Industry Calendar lists more than 100 national and international electronics industry trade shows, meetings and conferences. The 16-month calendar is available from the Electronics Representatives Association (ERA).

Circle (202) on Fast Fact Card

## Price guide lists electron tubes

Richardson's product price list features part number listings and prices for electron tubes, cathode ray tubes, receiving tubes, camera tubes and 12V relays. The price list is for dealers and users.

Circle (208) on Fast Fact Card

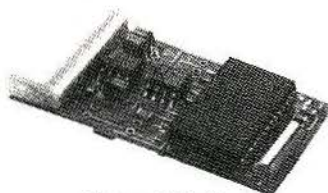
## Report evaluates future of PCNs

*PCN: The Future of Telecommunications?—An Analysis of the Emergence of Personal Communications* provides background information and detailed strategic insight into personal communications networks (PCNs); the evolution of personal communications; and the implications of these developments.

The 300-page report by **Impulse Telecommunications** evaluates new business opportunities in this field; describes the technology; and evaluates investments in the affected industries, such as cellular, telephone, paging and payphone companies.

Circle (201) on Fast Fact Card

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Circle (73) on Fast Fact Card



## Readers prefer NiCds for portable transceivers

Nickel-cadmium (NiCd) batteries are the most popular type of battery used for portable transceivers, according to the respondents to the June 1990 "What Do You Think?" questionnaire. An overwhelming 98% of the respondents use NiCds to power their portables, and 93.9% have purchased batteries in the last 12 months.

NiCd battery delivery is not a problem for readers, 89.9% report. "Memory effect," however, has been a problem with NiCds used by readers as reported in the following statistics:

<b>'MEMORY EFFECT' IS A PROBLEM</b>	<b>%</b>
Yes	55.6%
No	40.4%
No response	4.0%


Exercising a battery improperly contributes to the "memory effect" prob-

lems, readers state. Comments include:

- "Personnel attempt to recharge batteries before they near discharge; battery life gradually decreases."
- "A battery doesn't hold a charge when it is dormant; you must 'deep cycle' a battery to avoid 'memory effect.'"
- "Proper charging eliminates any 'charging memory effect.' Proper run down and draw also helps."
- "Memory effect is a misunderstood phenomenon. Somebody should publish a NiCd handbook."
- "It is difficult to teach users to intentionally discharge batteries periodically."
- "Problems stem from: 1) A user leaves a battery in a charger all of the time when not using the battery. 2) The radio does not 'see' a complete duty cycle before it is charged again. 3) Even our technicians who know better leave dozens of radios in chargers for

prolonged periods so they are ready on short notice."

- "A lot of portables are used as short-term supplements to system, and the lack of any long-term usage induces 'effect.'"
- "The memory of NiCds is a horrendous problem in emergency services. Every user wants fresh batteries, so the batteries are recharged every shift change."
- "Customers' batteries develop memories because of repetitive use. I cycle all transportable batteries when the radios come in for repair."
- "Personnel work specific shifts day after day. NiCds learn this and 'quit' at the end of a shift."

Readers prefer to use NiCds because of longer life, quick recharging and availability. Developments readers relish in battery technology include higher capacities, longer life, smaller designs, lighter units and better housings. 

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For more information on these and other Lucas Ledex Sub-SCADA systems, send for our new catalog.

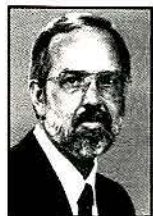
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Nation



Reese



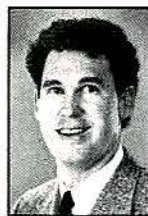
Clark



Wood



Beam



Jehle



Short

Area sales managers named at Midland LMR, Kansas City, MO:

**Larry A. Nation** advances from customer service representative to area sales manager for Georgia and the Florida panhandle.

**Robert H. Reese** leaves Secom Systems, Atlanta, as regional sales representative to cover North Carolina and South Carolina as Midland area sales manager.

**Robert W. Clark** exits Motorola, Schaumburg, IL, as account executive to handle Kentucky and Indiana accounts.

**Mark D. Wood** departs Fleetcall, Bloomfield, NJ, as sales manager to represent accounts in Oklahoma and northern Texas.

**James B. Beam** exits Motorola, Schaumburg, IL, as a customer service representative to become area sales manager for Ohio, West Virginia and western Pennsylvania.

In other Midland appointments:

**Bob Jehle** leaves Motorola, Schaumburg, IL, as its sales representative for special accounts and products to become Midland bid specialist.

Appointments at Richardson Electronics, LaFox, IL:

**Bill Short** advances from district sales manager for Richardson Canada to regional sales manager for Canadian operations.

**Chris Cane**, former regional sales manager for Canadian operations, advances to vice president of sales for Richardson.

**Joe Mueller** is district sales manager of Minnesota, Nebraska, North Dakota, South Dakota and Wisconsin.

**Bob St. Clair** is district sales manager of Idaho, Oregon, Utah and Washington.

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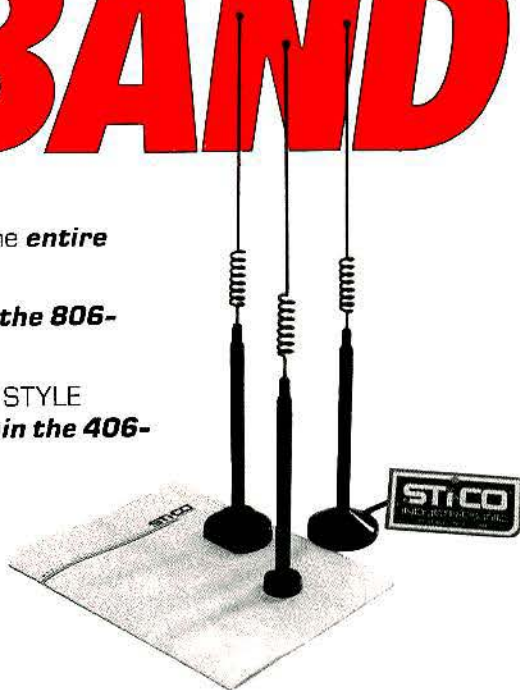
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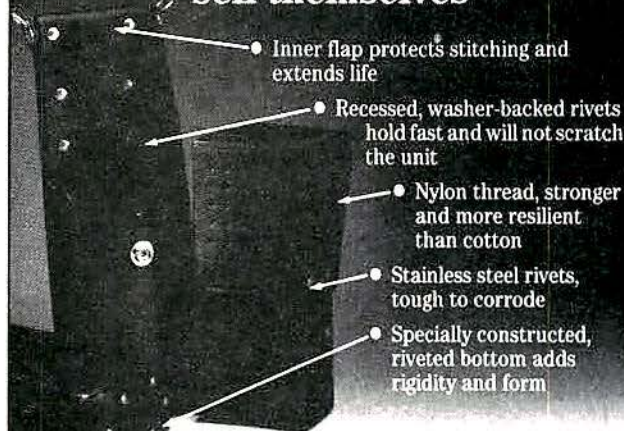
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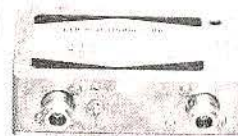
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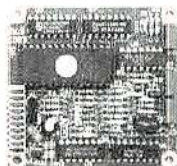
Typical rejection:

± 600Khz @ 145 Mhz: 28db  
± 1.6 Mhz @ 220 Mhz: 40db (44db GaAs)  
± 5 Mhz @ 450 Mhz: 50db (60db GaAs)

± 20 Mhz @ 800 Mhz: 65db  
± 20 Mhz @ 950 Mhz: 70db

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## People

**Barbara Pratt**, exhibits manager at Telocator, Washington, DC, moves up to director of programs and exhibits.

Appointments at Metro Mobile, New York:

**Jack D. Plating**, vice president and general manager of the Greenville, SC, operation, advances to vice president of the southeast region.

**Richard S. Fahrney**, western region sales manager for Nokia Mobira, joins Metro Mobile as vice president sales for Phoenix and Tucson.

**Kim Ruane** exits N.W. Ayer as personnel manager to become human resources director at Metro Mobile's New York office.

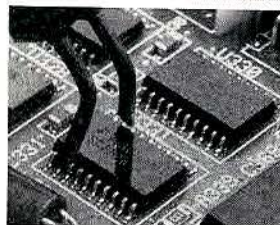
**Michael S. Hirsch** leaves US Sprint's Telenet Communications as its business development director to become vice president of technology for the Cellular Telecommunications Industry Association (CTIA), Washington, DC.

**James P. Caile** moves up from director of marketing to vice president of marketing for Motorola's cellular subscriber group, Arlington Heights, IL.

**Stacey Black**, product manager at International Teletrac, Inglewood, CA, advances to vice president and general manager for the company's Los Angeles operation.

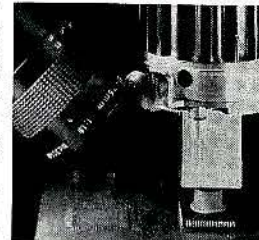


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## January

16-18—Cellular Telecommunications Industry Association 1991 Winter Meeting and Exposition, San Diego. Contact: 202-785-0081.

## February

12-14—Mobile Data World, Hyatt Regency Capitol, Washington, D.C. Contact: Ram Mobile Data, 212-373-1930.

25-26—American SMR Network Association New Technologies Symposium and SMR Expo, Westcourt in the Buttes, Phoenix. Contact: 202-331-7773.

## March

3-6—Energy Telecommunications and Electrical Association '91, George R. Brown Convention Center and Hyatt Regency, Houston. Contact: 214-235-0655.

11-13—Associated Public-Safety Communications Officers 23rd Western Regional Conference, Red Lion Motel, Salt Lake City. Contact: 801-965-4087.

26-28—International Mobile Communications Expo, Anaheim Convention Center, Anaheim, CA. Contact: 303-220-0600.

## April

23-26—Mobile Communications North America, Toronto Convention Center, Toronto, Canada. Sponsored by Telocator and Radiocomm. Contact: 800-422-4862.

## May

8-11—National Association of Business and Educational Radio Annual Meeting, Westin O'Hare, Chicago. Contact: 800-759-0300.

19-22—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Sheraton West Port Inn, Maryland Heights (St. Louis), MO. Contact: Jay Underdown, 314-946-9980.

## June

25-27—Utilities Telecommunications Council 43rd Annual Meeting, Hyatt Regency Ohio Center, Columbus, OH. Contact: Rita Clark, 301-621-7802.

## July

21-24—Forestry-Conservation Communications Association, Great Smokies Hilton, Asheville, NC. Contact: Don Pfohl, 602-644-3166.

## August

5-10—National Professional Electronics Convention, Nugget Hotel, Sparks, NV. Contact: 817-921-9061.

12-15—Associated Public-Safety Communications Officers 57th National Conference, Tulsa, OK. Contact: 800-824-1850.

## September

19-21—Mobilexpo & Cellular Showcase, Orange County Convention Center/Civic Center, Orlando, FL. Contact: 303-220-0600.

21-25—International Association of Fire Chiefs Annual Meeting, Toronto. Contact: 202-833-3420.

25-28—Special Industrial Radio Service Association Annual Meeting, Hyatt Lake Tahoe, Incline, NV. Contact: Barbara J. Levermann, 703-528-5115.

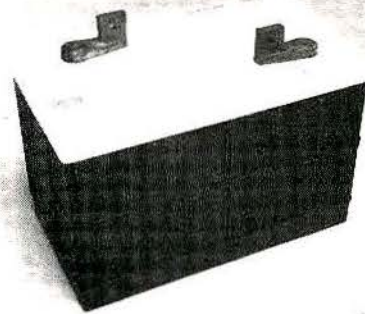
## October

5-10—International Association of Chiefs of Police Annual Meeting, Minneapolis. Contact: 703-243-6500.

21-24—Mobile Communications Marketplace, Anaheim Convention Center, Anaheim, CA. Contact: Telocator, 800-422-4862.



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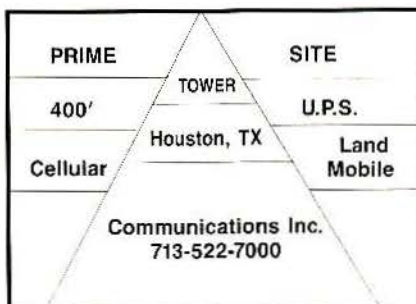
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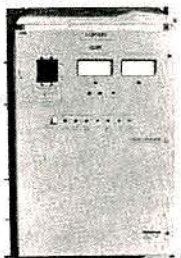
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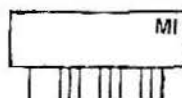
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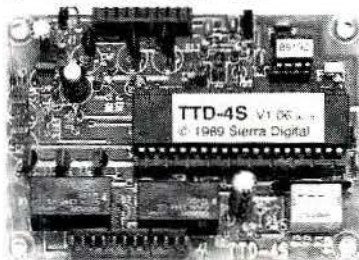
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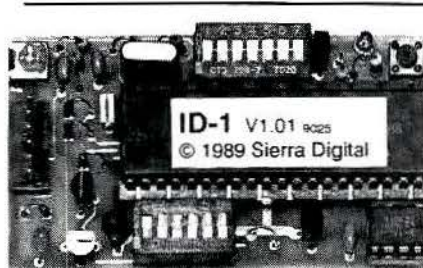
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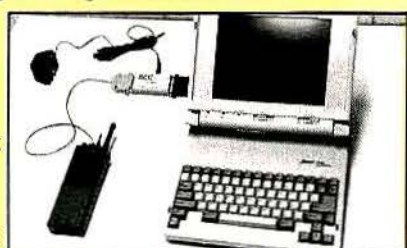
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  - Checking transmission line and trimming to resonance
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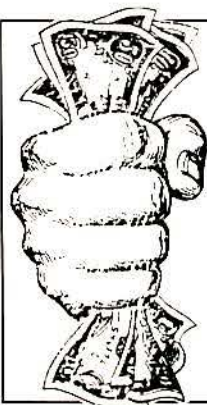
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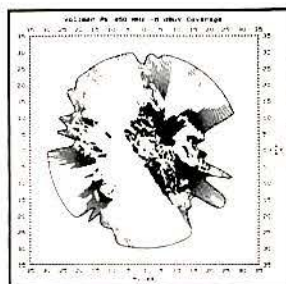
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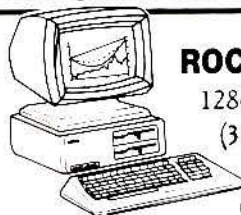
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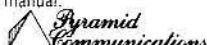
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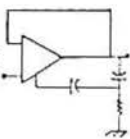
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Advanced Videotech Corp.	38	82	203/582-9409	Neutec, A Div. of Ranger Comms.	47	41	619/587-0656
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Berry Controls, Inc.	82	101	412/746-8888	Orbacom Systems, Inc.	33	27	609/829-4455
Bomar Crystal Co.	81	99	800/526-3935	Pace Inc.	74	78	301/490-9860
Cal Crystal	68	69	714/991-1580	PageTek Inc.	60	55	919/876-8294
California Radio	79		800/231-0103	PanaVise Products Inc.	59	54	702/353-2900
Cardion Electronics Inc.	18	13	516/289-6200	Parkinson Electronics Co.	79	93	800/332-7003
Cartwright Communications Co.	17	12	800/543-8614	RAB Parts Inc.	79	92	412/873-4600
Celwave	11	9	800/321-4700	Radiation Systems Inc.	68	68	312/298-9420
Centurion International, Inc.	46,80	40,94	800/228-4563	Ramsey Electronics	42	36	716/924-4560
CES Inc.	7	7	800/327-9956	Reach Electronics	48	42	308/324-6661
Communications Associates, Inc.	82	103	800/435-9313	Rocky Mountain Comms Inc.	84,85		303/988-3395
Communications Specialists	BC	3	800/854-0547	Schlumberger Instruments	31	25	617/229-4825
Control Signal Corp.	24	18	303/989-8000	Securiton Co.	66	63	408/263-6434
Cushcraft/Signals Corp.	21	16	603/627-7877	Selectone Corp.	71	73	800/227-0376
Cushman Electronics Inc.	87	110	408/432-8100	Selcom Corp.	70	72	415/965-8020
Cybersym Control Sys	85	107,108	703/268-5400	Shure Brothers Inc.	25	19	800/257-4873
Data Signal Inc.	32	26	912/883-4703	Sierra Digital	80	95	916/966-7776
Decibel Products, Inc.	50,51	45,46	214/631-0310	Siglone, Inc.	54	49	714/842-7855
Doppler Systems, Inc.	69	70	602/488-9755	Sinclair Radio Laboratories	29	23	716/874-3682
Dynatech Tactical Comms Inc.	28	22	800/233-8639	Skyline Antenna Management	77	90	203/673-0380
Ericsson Paging Systems Inc.	45	39	800/777-8194	Solar Electric Specialties Co.	75	79	800/344-2003
ESA Telecommunications Inc.	56	51	708/424-6464	Solid State Communications	3	5	800/227-1226
Freeman Engineering Associates, Inc.	13	10	504/831-7785	Sonic Communications Inc.	75	80	603/878-1944
General Communications	81	100	800/356-3200	Southern Computer Corporation	81	98	800/752-3571
GLB Electronics Inc.	74	77	716/534-5280	Standard Communications Corp.	19	14	213/532-5300
Hark Systems Inc.	39	32	800/FOR-HARK	Statistical Control Systems Corp.	58	53	813/954-8816
Henry Radio	37	30	800/877-7979	Sti-Co Industries, Inc.	73	75	716/662-2680
Hutton Communications	65,67,69	62,67,71	800/442-3811	Sunelco	66	64	800/338-6844
Hy-Q International	81	97	606/283-5000	Telex	52	47	604/270-1389
IFR Systems, Inc.	35	29	316/522-4981	Transcript Intl. Inc.	5	6	800/228-0226
Interconnect Specialists, Inc.	44	38	407/332-0533	Trident Micro Systems	42	35	714/549-5206
International Crystal Mfg. Co. Inc.	64		405/236-3741	Unipage, Inc.	15	11	214/224-3509
Larsen Electronics Inc.	57	52	206/573-2722	VCP International Inc.	64,65	60,61	214/271-7474
Lindgren R.F. Enclosures Inc.	40	33	312/307-7200	VCP International Inc.	66,67	65,66	214/271-7474
Lucas Ledex Inc.	72	74	513/454-2324	Vega	1	4	818/442-0782
Magellan Systems Corp.	49	44	818/358-2363	Vocom Products Corp.	20	15	800/USA-MADE
Marketronics Corp.	48	43	800/683-6275	Yaesu USA	IBC		213/404-2700
Maxon	53	48	816/891-6320	Zetron, Inc.	55	50	206/820-6363
Maxrad Inc.	41	34	312/595-3933	ZK Celltest Systems	34	28	408/735-7076
Midian Electronics, Inc.	30	24	800/MID-ANS				
Midland International LMR	23	17	800/MID-LAND				
Mobile Mark Inc.	63	58	312/671-6690				



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FTH-2070  
(FNB-16 Battery)



FTH-2009  
(FNB-19 Battery)



FTH-2008/7008  
(FNB-17 Battery)

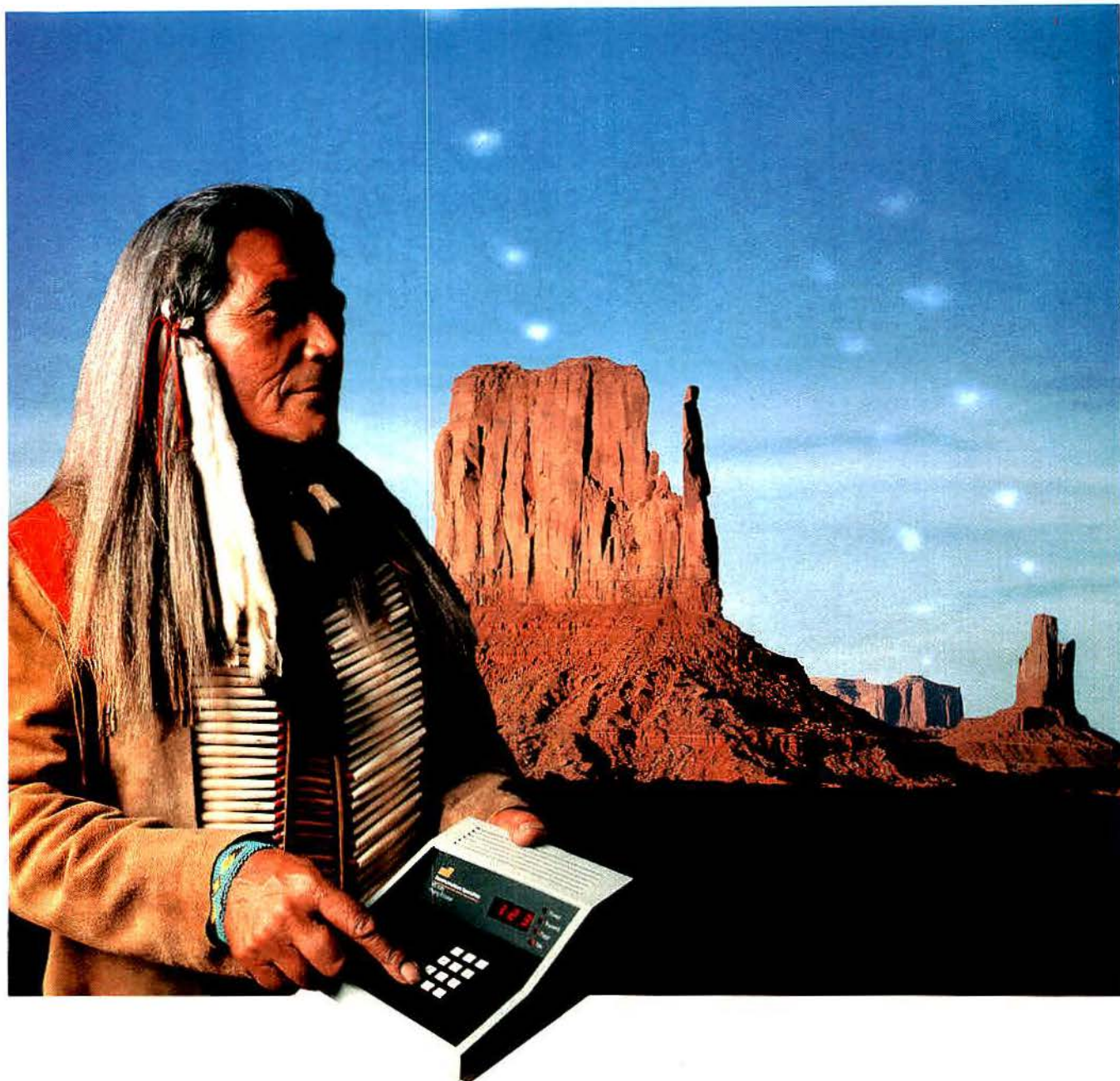
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